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A Government Power Dam for Municipal Use

Under quite exceptional circumstances, the United States Government is building a dam in the Mississippi River between St. Paul and Minneapolis, to impound water for 12,000- to 15,000-hp. development, and will probably lease the power site to the two cities and the University of Minnesota.* This is the first case, we believe, where such a relation between the government and local communities has been brought about.

The government is building the dam for both navigation and power purposes. At one end of the dam is built a lock, at the other end a power-house substructure or set of wheelpits. The user of the power will have to install the machinery and the power house covering it, as well as transmission lines, etc.

Construction by Force Account—Building the lock and dam is carried on as a force-account job by the U. S. Engineer Office at St. Paul. Work on an earlier project on the same site, carried on from 1907 to 1910, was handled in the same way. The work has gone on with perfect smoothness and—so far as indicated by the figures given out up to now—very economically. It is expected that the final record will show low cost figures.

Original Features—The enterprise is full of original features. The dam, a hollow reinforced-concrete structure, has its deck made of premolded reinforced-concrete beams laid on the buttresses and anchored to them. The lock, while of ordinary type in both original (13-ft. lift) and final (30-ft. lift) form, involves the unusual feature of walls raised to more than double their original height, and thickened to correspond. The lower gate of the lock is of the vertical-framed type, a type rarely used; it miters at the top only, while at the bottom it bears against the sill and exerts no thrust at the miter joint. The power-house substructure is designed so as to take either vertical or horizontal turbines, with generator room either on top or alongside the downstream wall of the foundation. This latter arrangement was resorted to because the government wanted to leave the user free in his choice of type of machinery. The construction also includes fall-increasers for the turbine draft-tubes, and débris sluices and log sluices.

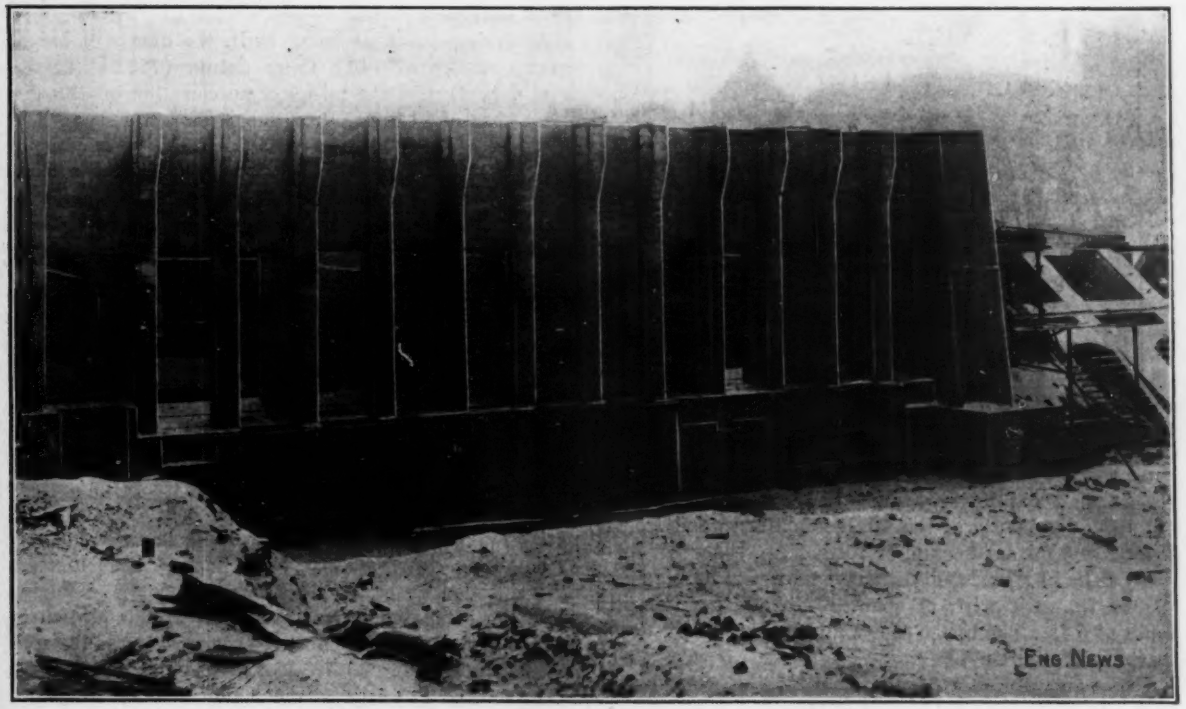

FIG. 1. POWER-HOUSE SUBSTRUCTURE OF ST. PAUL-MINNEAPOLIS DAM

(Upstream side. Photographed Jan. 27, 1914, before coffer-dam was removed. Exciter bay at left. Three main wheel bays are shown, each having four stop-log openings. Fall-increaser openings below. At extreme right, dam buttresses and sluiceway gate seats.)

*This matter is now before Congress, in the shape of a bill which would authorize such lease.

Various phases of the actual construction work are equally original with the above structural elements.

The present article describes this novel power project as a whole, leaving its separate elements and construction details to be described on other occasions.

Original Project for Two Low Dams

The original 2-ft. low-water depth in the Minneapolis end of the 14 miles of river lying between the twin cities at no time was able to carry commercial vessels. Twenty years ago, a project for canalizing the river in this section was worked out by the government engineers, and Congress approved this project in 1894. Two timber-crib

Fig. 2. Location Map of St. Paul-Minneapolis Dam

dams were to be built—No. 1 at Minnehaha Creek. 6 mi. above the Omaha railway bridge in St. Paul, or about 3½ mi. above the mouth of the Minnesota River; and No. 2 at a point 3 mi. farther up, or about 3 mi. below St. Anthony Falls in Minneapolis. Each dam was to have a lock 80x324 ft., with a lift of about 13 ft. and a miter-sill depth of 5 ft. The upper pool would be about 6 ft. deep nearly to the falls.

Various causes delayed the start of the work until 1898. In that year construction of Dam No. 2, the upper dam (see sketch map, Fig. 2) was begun, as this dam by itself could support navigation between St. Paul and Minneapolis at least two months in the year, while the lower dam by itself would give only one month's navigation. The concrete lock-chamber and the timber dam at No. 2 site were built under the disadvantage of interrupted appropriations, and thus were not completed until the end of 1906.

In 1907, the lock chamber of Dam No. 1, the lower dam, was started, and by 1909 it was completed.

The Power Project

New ideas were developing meantime. The people of the region looked toward the power possibilities of the dams; the same water would pass them that has for years been supplying water to the Minneapolis mills at St. Anthony Falls. But studies of the power question showed that the two low-head dams would not be economical sources of power as compared with a single dam of the combined head. Upon working out the single-dam project, the conclusion was reached that the old project should be abandoned and the new project adopted. Congress authorized the change in the 1910 River and Harbor Act. The lower dam is being built to a height of 30 ft., and Dam. No. 2 will be submerged, a few feet of its top having been blasted off to give the required channel depth.

The navigation side of the project was modified somewhat in the same revision. A 6-ft. depth was adopted in place of the old 5-ft. depth, and the lock is expected to give 7 ft.; river works below have been planned to give 6 ft. Some account, even, has been taken of a possibility that 9½-ft. navigation may be wanted in the remote future. The dam is higher than the combined height of the original project, and the upper reach and upper entrance of the lock will give the 9½-ft. depth. But the river below the dam would need to be raised for a 9½-ft. depth at the lower entrance, by wing dams or equivalent work.

As designed and as being built, the dam will have a crest elevation of 743.5 Cairo datum (722.24 ft., sea-level datum), and the tailwater an elevation of 712, giving a head of 31.5 ft. Provision is made for using 3 ft. of flashboards, and the river work below will probably lower the tailwater about a foot. Thus the low-water head will be 32.5 without flashboards and 35.5 with flashboards. At high water, the head may be reduced to about 26 ft. Normal floods are expected to flow 4 to 5 ft. over the crest. The upper lock gate and the lock walls are built for extreme floods (never recorded, but believed to be remote possibilities) of 9 to 10 ft. over the crest.

The dam crest is 575 ft. long; out of a river width of about 900 ft. the lock takes up about 100 ft. and the power house about 200 ft.

This power development has an intimate relation to the famous Mississippi headwaters reservoir system. Beginning in the early '80's, a series of six large storage reservoirs was built about 400 miles above Minneapolis, partly by raising the levels of existing lakes and partly by damming river valleys. Their purpose is to increase navigable depths on the Mississippi above Lake Pepin; while the navigation actually existing in this stretch of river is very small, the effect secured in increased depth is considerable.

The normal drainage of the region aided in midsummer by the reservoir discharge, keeps the flow at St. Paul well above a minimum of 5000 to 6000 cu.ft. per sec. throughout the spring and summer months and on into late autumn. Beginning about November, a natural low-water stage and the closure of the reservoirs brings the flow between November and the middle of March to a point below 3000 and sometimes down to 1500 cu.ft. per sec. The high-water flow (June) rarely goes up to 40,000 cu.ft. per sec.; 60,000 is taken as a remote possibility.

The flow at St. Paul is augmented by the Minnesota River. At the dam it is figured at 4000 sec.-ft. summer flow for power.

Under these conditions, the power of the river at 35-ft. head can be taken at about 12,000-15,000 hp. utilizable for nine months of the year. The winter power, however, may at times drop as low as 5000 hp. The consumption of current for lighting, pumping and some minor uses

by the two municipalities and by the State and Federal authorities in the local territory amounts to about 3000 kw. (4000 hp.).

The power-house substructure at the dam has been designed for four 3800-hp. units. If this capacity is installed and full demand develops, auxiliary power must be generated or bought, to bring up the deficit during the period from November to March. It is probable that a steam power station would be built as a supplementary source as soon as the demand grows beyond the winter power.

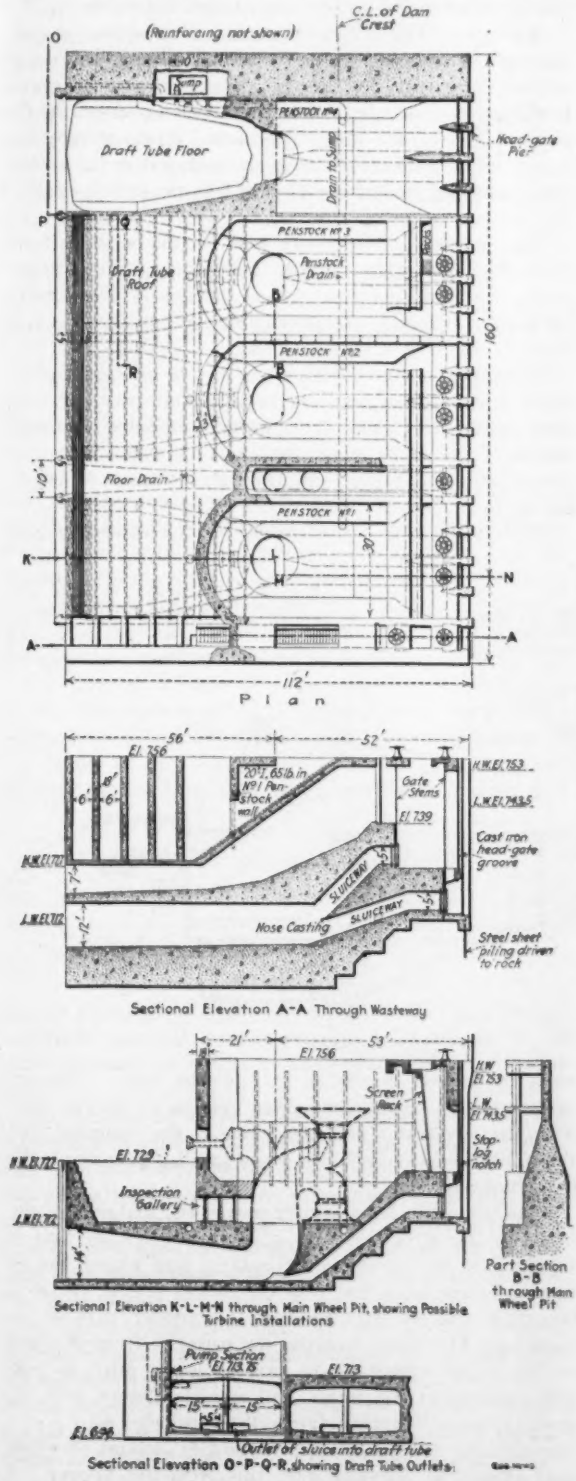

FIG. 3. PLAN AND SECTIONS OF POWER-HOUSE BASE, ST. PAUL-MINNEAPOLIS DAM

The power-house layout is sketched by the two sections and the plan in Fig. 3. At the land end of the four cells or chambers is a narrow bay divided into three sluiceways, one above the other, the lowest two, merging into a common outlet, being the débris chutes, while the upper one is a log chute. Between the first and second power bays from the land end is a narrow exciter bay. The power bays are simple vertical cells divided by a floor some distance above the downstream pool level, which separates the headbay from the tailbay or draft-tube section. The draft tube is a curved tapering passageway changing from circular to rectangular section, and at the same time bending from vertical to horizontal direction. At its lower bend an opening from the upstream side enters; this serves partly as sluiceway and partly as fall increaser (Herschel style). The exciter draft tube has no such fall increaser. The position of screen racks, gates, and stop-log notches is apparent from the drawing.

The water-wheel chambers are intended to be large enough to accommodate either vertical or horizontal wheels. In the case of vertical wheels an intermediate machinery floor would have to be built, and over it a house inclosing and covering the waterwheel cells. In the case of horizontal wheels the power house would be downstream of the lower forebay wall, on a ledge provided for the purpose above the draft tube.

The principal change made from the original designs of Gardner S. Williams, of Ann Arbor, for the hydraulic layout was shifting the exciter bay one panel toward the land—it was originally located between the second and third cells—and making the downstream walls of the forebay in the shape of three chords to the original circular arch.

This concrete substructure is fully reinforced in all directions. The vertical partitions between the wheel cells were designed and reinforced as cantilevers to resist the pressure when one cell is full and the adjoining one empty. In a similar way the downstream walls of the wheel cells are designed as cantilevers from the dividing walls; at the middle of each of the downstream segmental walls there is an expansion joint, to localize any possible formation of cracks.

The foundation work at this locality was somewhat troublesome, inasmuch as the St. Peter sandstone rock which forms the almost vertical bluff of the river gorge dips down below foundation level at about one-third the length of the power house out from the land end. The result is that part of the power house rests on rock and part rests on piles—1200 piles, 10 to 20 ft. in length. The subsoil here is a sand and gravel river deposit which is believed to be very hard and firm. No differential settlement of the two parts of the foundation is anticipated.

The lock and dam were designed by the U. S. Engineer office of the St. Paul District. Up to August of 1912, Lieut.-Col. F. R. Shunk was in charge of the district, and since that period Lieut.-Col. Charles L. Potter has been in charge. During both administrations the work was under the superintendency of Assistant Engineer Geo. W. Freeman, who has also been in charge on the ground as works superintendent.

Operation of Sand and Gravel Plants

By W. H. Wilms*

SYNOPSIS—This is a continuation of the article on "Development of Sand and Gravel Deposits," by Mr. Wilms, in Engineering News, *of Nov. 5, 1914, p. 998. The present article discusses the necessary equipment for a screening, washing and crushing plant, method of operation, the necessary facilities for a successful plant, with many recommendations based on several years' operative experience.*

Screening and Washing

Screening—The conical revolving screen, better known as the Gilbert screen (patent rights run out) has now practically supplanted all other types of screens in the screening and washing of sand and gravel. The screen is cantilevered, being supported at one end only, except in the very large sizes when the screen shaft extends through the screen with a bearing at each end. The small end of the screen is closed by a solid casting, to which the screen shaft is fastened. In the operation of the screen the material is carried to the small end of the screen by a chute (Fig. 1), which runs into the screen and discharges almost against the head at the small end.

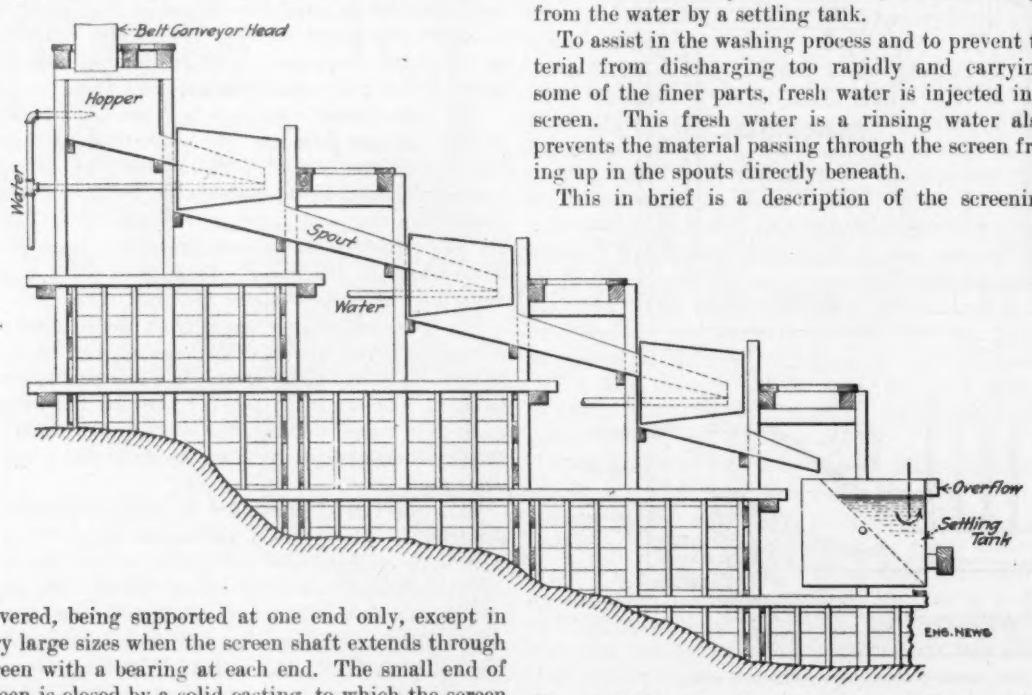

Fig. 1. Ordinary Arrangement of Gilbert Screens

The material, therefore, must reverse in direction to work out of the screen, and in so doing practically all of the original velocity gained in the feeding chute is lost at this point, and the gravel passes slowly and evenly through the screen, due to its rotation and inclined sides. Thus the entire screen surface becomes effective, and large capacity and uniform sizing result.

The screens are generally arranged in a series as shown in Fig. 1. The over-size from the first screen drops into the first bin, and the material which passes through the perforations is carried by water through a spout into the far end of the second screen. This process is repeated for each size of material separated.

The first screen has usually 1½-in. or 1¼-in. perforations, and all material over 1½ (or 1¼ in.) is discharged into a chute leading to the crushers for reduction.

Washing—The washing process now begins, the revolving motion of the screens breaking the soil and foreign matter away from the gravel. The next size of gravel is separated from the mass by the second screen in the same manner as the first. The second screen usually has ¾- or ⅝-in. perforations, and the material in the second bin is everything between 1½- or 1¼-in. and ¾- or ⅝-in.

The remaining screens are sand screens with perforations dependent upon the size and grade of the sand desired. After the material passes through all the screens the sand and muddy water remain, the sand being taken from the water by a settling tank.

To assist in the washing process and to prevent the material from discharging too rapidly and carrying over some of the finer parts, fresh water is injected into each screen. This fresh water is a rinsing water also, and prevents the material passing through the screen from piling up in the spouts directly beneath.

This in brief is a description of the screening and washing process in use at the present time. The arrangement of screens and other details, of course, vary with the conditions and the ideas of the operator, but the process is essentially the same in all plants using the Gilbert screen.

Precautions—By whatever means the material is elevated to the screening top, it is quite essential that it should first be delivered into a large and ample box or hopper before being fed into the initial screen, for it is here that the material receives the greater part of its washing. The chute carrying the material from this box to the initial screen should have as low a pitch as possible, otherwise the water will quickly escape and its washing and scrubbing action will be rendered nil.

Ordinarily at least 60% of the entire amount of water used should be delivered into this receiving hopper. I recently visited a large plant where this hopper was nothing more than an extension of the chute leading into

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the initial screen. This chute was on about a 45% slope with the result that the water injected into the material flowing in the chute had no washing action whatever. The material has been so imperfectly washed as a result of this feature that the superintendent of the plant has decided to tear down the present arrangement and rebuild.

WASH WATER—There are several methods employed in applying water to the material in the screen, depending upon the amount of dirt and impurities in the gravel and the size of the screen perforations. Fig. 2 shows the ordinary method when the dirt, clay or other impurities are in the free state and easily washed out.

When the material contains considerable foreign matter, or the gravel is coated with a hard film of clay, it is often necessary to supplement the spray pipe, shown in Fig. 2,

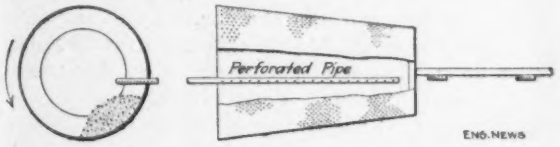


FIG. 2. ORDINARY METHOD OF APPLYING WATER TO SCREENS

with an injection of water under pressure in the manner shown in Fig. 3. The pressure of this stream tends to keep the material in the screen for a longer period, resulting in a more thorough washing. In the screening of some sands that have a tendency to clog the screens, it is often necessary to keep a spray of water playing on the outside screening surface to prevent this (Fig. 3).

AMOUNT OF WATER—The amount of water necessary for the thorough washing and cleansing of the material depends upon the amount of impurities contained in it, the nature of the impurity, whether loam or clay, and whether or not this loam or clay is finely divided and

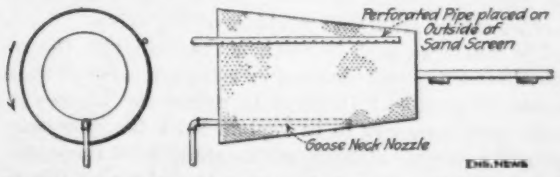


FIG. 3. METHOD OF APPLYING ADDITIONAL WASH WATER

in a free state or covers the material in the form of a hard film.

The amount of water necessary also depends upon the percentage of sand contained in the gravel being screened and upon the nature of the sand, whether light or heavy, fine or coarse. As a minimum for reasonably clean bank or stream deposits, 1 gal. per min. per cu.yd. of material should prove effective, although if the percentage of sand runs high, this figure will probably have to be increased. Too much water can hardly be used—the more water the more effective the screening. Extremely dirty material will often require double the above amount, and even then the results are not likely to prove entirely satisfactory.

The necessity of an adequate and reliable water supply cannot be too strongly emphasized. I know of an instance where an efficient and otherwise promising plant proved an utter failure due to the impossibility of obtaining a sufficient water supply for effective washing and screening. This feature is of equal importance with the quality of the bank gravel itself, and the determination as to whether there is a sufficient and reliable water supply available should be one of the first considerations in a new development.

RE-USING WATER—A number of plants that are suffering from a lack of sufficient water—and there are many—have improved the quality of their product considerably by using part of the water over again. The waste water from the settling tank is permitted to flow into a storage tank provided with an overflow, located either upon the top of the storage bins or upon the ground. A centrifugal

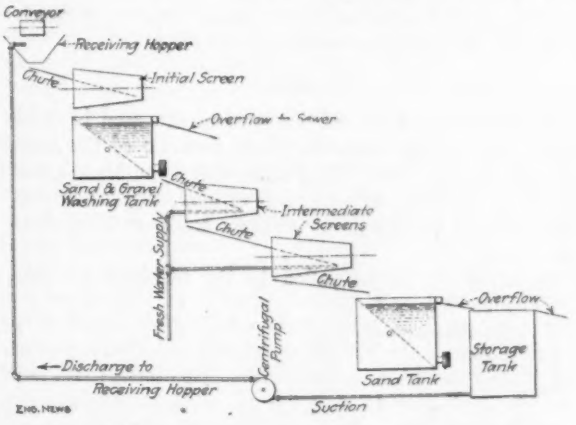


FIG. 4. WASHING ARRANGEMENT WITH AUTOMATIC SETTLING TANKS

pump is used to pump this waste water from the storage tank back to the gravel hopper at the head of the screens. No fresh water is used in the gravel hopper, the preliminary washing here being effected with this return waste water.

While this method will undoubtedly improve the quality of the material where the water supply is insufficient, it can be improved upon considerably by providing an arrangement whereby this return waste water after effecting the preliminary washing in the receiving or gravel hopper is not permitted to enter the screens, but is allowed to run to waste. The present methods of washing sand and gravel without exception are all open to the objection of permitting the dirty water from the receiving hopper to travel with the material through the entire battery of screens to the settling tanks. When it is considered that the greater part of the washing is effected in the receiving hopper, the reason why some plants handling dirty material are not producing a clean product becomes apparent.

It is my contention that with dirty material, and most bank gravel contains far more dirt and foreign matter than is generally realized, the water used in the preliminary washing should be taken from the overflow of the settling tanks and should not be permitted to enter the sizing screens at all.

With the same amount of water, a plant washing its material in this manner would undoubtedly produce a cleaner and better material than with present methods. To effect such an arrangement for washing, it would only be necessary to first deliver the material directly from the receiving hopper to the initial screen to take out the oversize and then deliver it to a settling tank, similar in design and operation to a sand-settling tank, for taking off this dirty water. The initial screening is necessary so

as to remove the coarse material which would otherwise clog up the discharge openings of the tank.

AUTOMATIC SETTLING TANKS—Extensive test runs with automatic settling tanks handling 1½-in. material and sand show that such tanks when properly designed with large discharge openings will operate satisfactorily when used for this purpose. It should be understood, however, that complete washing of the material in such a tank is not to be expected, as a considerable quantity of the dirty water must of necessity pass out of the tank with the material to cause it to flow and discharge itself. More than half of the dirt and impurities, however, can ordinarily be removed by the tank. Fig. 4 is a sketch of the washing arrangement above outlined.

SCREENS

Both round and slotted perforations are used in sand screens, depending upon the shape and size of the sand grains. A great many river sands and some bank sands contain a considerable percentage of long, angular-shaped grains, while the grains of common bank sand are usually round.

Attention should be called to the necessity of providing at least one intermediate screen between the initial and sand screens. Any attempt to screen out all of the sand by means of only two screens will almost surely result in failure. Where all of the material passing through the initial screen is taken direct to the sand screen, as is only too often the case, the sand screen becomes overcrowded and unable to effectively perform its screening, resulting in a large percentage of the sand and dirty water going over the screen with the gravel.

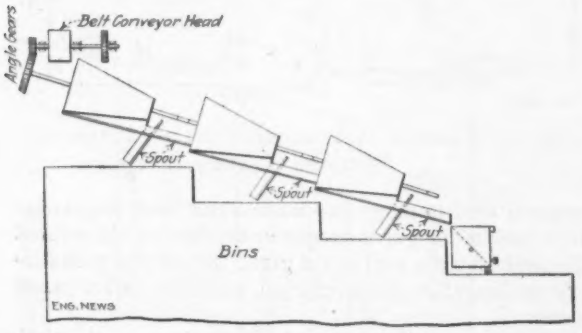


FIG. 5. BATTERY OF SCREENS OF A NEW TYPE MADE BY THE RAYMOND W. DULL CO., CHICAGO, ILL.

I have seen instances where this crowding of the sand screen was deliberately done to get rid of some of the sand, of which there was an excess in the bank and which could not otherwise be disposed of. It is done, however, only at a sacrifice of the quality of the material produced. To prevent crowding and to permit of effective screening, an intermediate screen should be used even though there may be no demand for the size of the material the screen produces.

PERFORATIONS—In screening river sands it is often necessary to use a round perforation, as these long, angular particles of sand would effectively clog up the perforations of a slotted screen, whereas a round hole will reject them. I have also had experience with a sand that, when screened through a screen having round perforations, would so effectively clog them up as to require the use of a center-punch and hammer to clear the holes. With a slotted screen, however, I had no trouble in getting this sand through without clogging.

In the manufacture of sand screens, that side of the screen plate upon which the punching of the perforations was performed should be made the inside or wearing surface of the screen. Punched holes in steel plate are slightly larger upon die side than upon the other, and in order that the perforations may freely pass through any particle when once started, it is necessary that the small diameter of the hole be on the inside. This feature, though a small one, has caused many operators much trouble and expense. While many screen manufacturers are aware and take care of this detail, many do not; therefore it should always be mentioned when ordering sand screens.

SPEED—The speed of conical screens that has been found most effective is from 12 to 14 r.p.m. for the ordinary size of screen, and 9 to 11 r.p.m. for the extremely large sizes. Faster speeds than this cause the material to climb up on the side of the screen with a consequent loss in screening capacity. From test runs it has been found that the most effective speed is that at which the material in the screen makes an angle of about 30° with the vertical.

PITCH—The screening surface of a Gilbert conical screen has a pitch of 1½ in. to the foot for all sizes. While many screens having different ratios of length to diameter at the small end are in use, the following sizes have more or less been standardized, having been found the most effective under average conditions (dimensions are given in the order of small diameter, large diameter and length):

24x36x54 in.	36x54x72 in.
28x44x60 in.	48x64x84 in.
	48x72x96 in.

SIZE—The size of screen necessary for a given capacity depends upon so many factors, such as size of perforation, uniformity of feed to the screen, amount of impurities in the material, amount of water, etc., that no table of capacities can be given that would be of any value.

The size most used, however, is the 36x54x72, the required capacity being obtained by using a number of these screens in parallel. In order to reduce the number of spare parts necessary to be kept in stock for emergency use and to permit of the interchangeability of the screen plates of the various screens, it is generally advisable to have all of the screens with the exception of the initial screen of the same size.

WEAR—The wear on screen plates is very severe and rapid; the perforated holes become enlarged, resulting in imperfect grading. As heavy a screen plate as practicable should be used. It should be remembered, however, that as the thickness of the screen plate increases, a larger diameter of hole becomes necessary for the screening of a given-size material. The following sizes of plates for the different sizes of perforations have been found by experience to be very economical and effective under ordinary conditions:

2- to 1¼-in. perforations, ½-in. plate.
¾- and ⅞-in. perforations, ⅜-in. plate.
⅝-in. perforations, ⅞-in. plate.
¼-in. round perforations, No. 14 gage.
⅛x½-in. slotted perforations, No. 14 gage.

SIZES OF PERFORATIONS—To make a given-size product, a larger diameter of screen perforation must be used, owing to the angle and thickness of the screen plate at the point where the stone passes through. The follow-

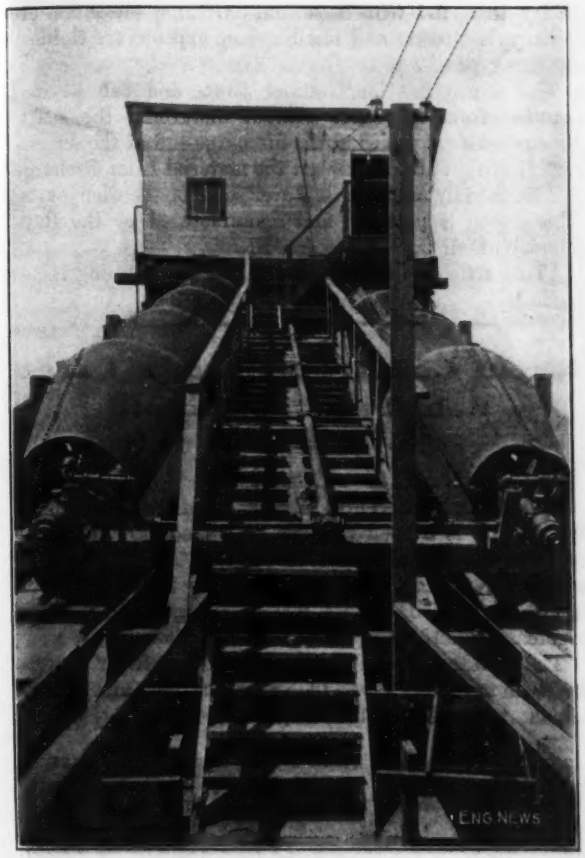


FIG. 6. BATTERY OF SCREENS; CHICAGO SAND & GRAVEL CO.

ing table gives the relative sizes of material and screen perforations:

Size of material	Screen perforation
¼-in.	⅛- to ⅜-in.
⅜-in.	½-in.
½-in.	⅝-in.
1-in.	1¼-in.
1½-in.	1¾-in.
1¾-in.	2¼-in.
2- in.	2½-in.
2½-in.	3- in.

CHUTES—The grade of the chutes or spouts into the screens, and of the outer skirts carrying the material passing through the screens, varies from 3 to 4 in. to the foot, depending upon the size of the material and the amount of water being carried.

The tendency here is to use too great a grade for the chutes between the various screens, resulting in an excessive height to which the material must be elevated. I know of a case where in the reconstruction of a certain large plant something like 8 ft. in elevation was saved by reducing the excessive chute grades between the screens. It is not unusual to see plants with chutes having grades as high as 8 in. to 1 ft.

The chutes between the gravel screens very rarely require a fall of more than 3 in. to 1 ft., while the chutes between the sand screens and settling tank can generally be operated on as low a grade as 1½ in. to 1 ft.

In the handling of very dirty gravel it is especially important that the grades of the chutes be no more than what is actually required, for in such cases it is necessary to introduce jets of water in the chutes to effectively wash the material. If the grades of the chutes be excessive the gravel will travel or flow about as fast as the water, consequently the scrubbing action of the water which would obtain on a flatter slope, would here be ineffective.

DOUBLE SCREENS—Where the screening out of the oversize material is performed on top of the plant at the head of the battery of sizing screens, it has sometimes been found advisable to perform this initial screening in the first sizing screen by means of an inner screen plate extending about 6 in. beyond the discharge end of the outer screen plate.

While this method eliminates an extra screen with the consequent saving in head room, a larger screen than is ordinarily required must be used to compensate for the decreased capacity of the outer screen plate.

This screen plate receives its material its entire length and not at the head end as is usually the case. Consequently, material passing through the inner screen plate and upon the outer plate at the end of the screen receives very little if any screening. For this reason, the screen must be made amply large where the two are combined in the above manner.

It is sometimes found advisable to provide a screen with an inner skirt or screen plate with perforations about ¼ in. larger than those of the outer plate, the skirt extending nearly the full length of the main screen plate. This is for the purpose of increasing the screen's capacity by relieving it of the larger sizes and for making the separations more accurate.

DEFLECTOR VANES—Where the material is extremely dirty, short pieces of angle iron bolted to the initial washing screen, and arranged spirally on the inside of the screen plate, have often proved effective by retaining the material in the screen for a longer period, resulting in a more thorough washing.

FIG. 7. STORAGE BINS; CHICAGO SAND & GRAVEL CO.

INCLINED GRAVITY SCREENS—In the operation of a plant, it is often necessary to use short sections of inclined gravity screens; such screens, however, should be used sparingly, for even under the best of conditions such screens produce a material that is very imperfectly graded. The material in sliding over the screen plate acquires a velocity in a very short time that prevents the material from going through the perforations. For this reason only the first 4 or 5 ft. of the screen are really effective.

Inclined screens of the bar type have the further objection of permitting a large percentage of over-size material to pass through the bar spacings. Neither can a thorough washing and cleansing of the material be effected on this type of screen. I have yet to see anything like a well graded and washed material produced over gravity screens.

A New Type of Screen—Mention should be made here of a washing screen that has been in service in a large number of plants throughout the country during the past two years. This screen is giving such satisfactory results that it is worthy of a brief description. One of the largest plants in the country with a daily capacity of 3000 cu.yd. is now installing a battery of 24 of these screens.

This type of screen is in many respects an improvement over the Gilbert screen. Referring to Fig. 5, the screens of a single battery are all mounted on the same shaft. A single pair of gears is used to drive all the screens, thus dispensing with a separate drive for each screen, with the attendant line shafting, bearings, gears, sprockets and chains. The material also travels differently in this style of screen, being delivered into the large end and traveling toward the small end as shown in Fig. 4.

The feature that appeals to the writer in this type of screen, however, is that the large end of the screen does the principal work. The large end has more perforations, more screening surface and consequently a greater capacity than the Gilbert screen. Greater screening efficiency, less power and small upkeep expense are claimed for this type of screen.

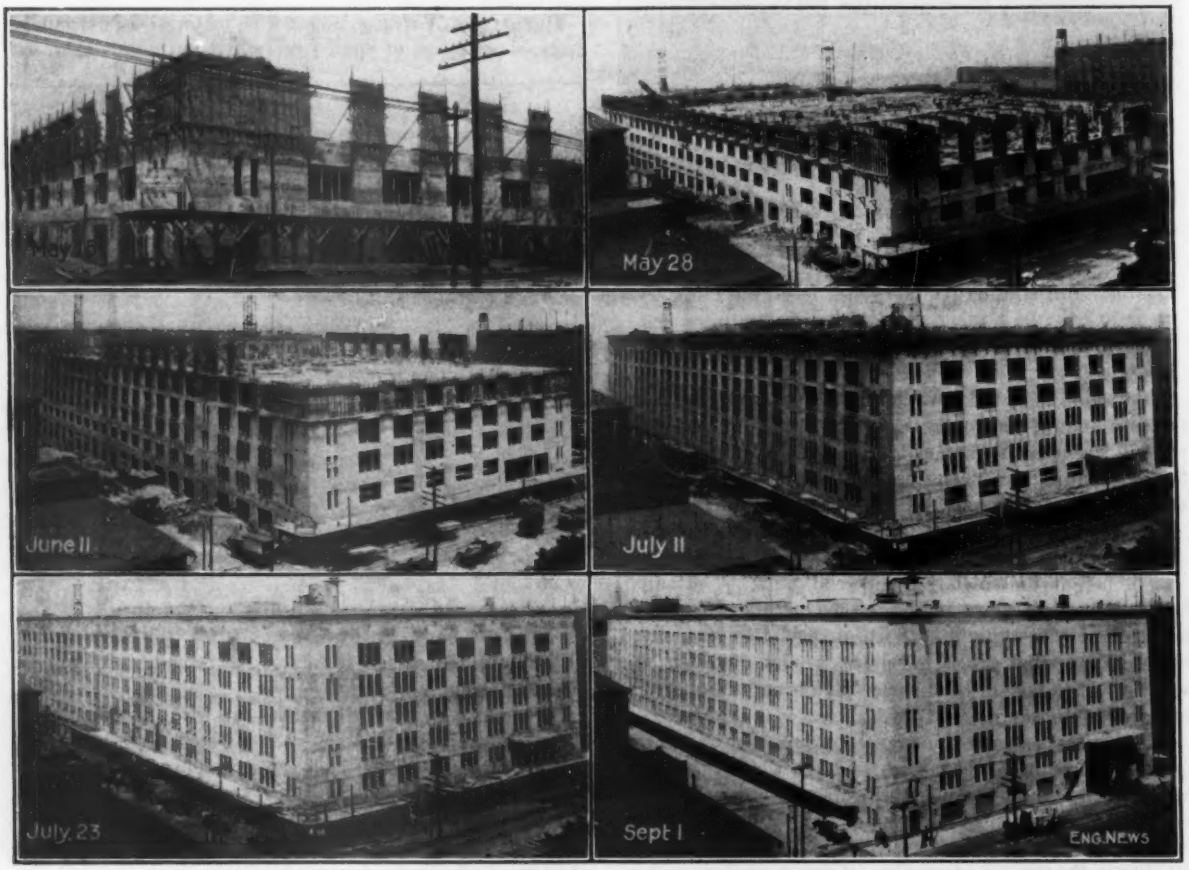
The screen has longitudinal joints and can be dismantled from the shaft without disturbing the shaft. Pipe nozzles are placed at the discharge end of the screens for injecting water to prevent the material from discharging too rapidly and carrying over some of the finer parts. This screen is patented and manufactured by the Raymond W. Dull Co., of Chicago, Ill.

[This article will be concluded in a forthcoming issue. —Ed.]

Rapid Construction of a Large Reinforced-Concrete Warehouse

The Austin-Nichols warehouse, which has just been completed at North Third St. and Kent Ave., in Brooklyn, N. Y., is a good example of a modern reinforced-concrete building of the warehouse type, and the remarkable progress made in its construction is indicative of what can be done in reinforced concrete with proper organization and supervision.

The building is located on the East River waterfront, immediately alongside of one of the railway terminals, tracks from which enter the second story of the



Figs. 1 to 6. Progress Views of Construction of Austin-Nichols Grocery Warehouse, East River Waterfront, Brooklyn, N. Y.

(Date of each view marked on cut; entire building completed in nine months.)

warehouse. These tracks are carried on steel girders and columns, but the entire remainder of the building is of reinforced concrete, the structure being of the regular column, girder and slab type. The building is 440 ft. by gravity. The other mixing plant, a duplicate of the first, was located at the other end of the building, and was approached from the storage bin by narrow-gage tracks, on which cars, driven by an endless cable, carried

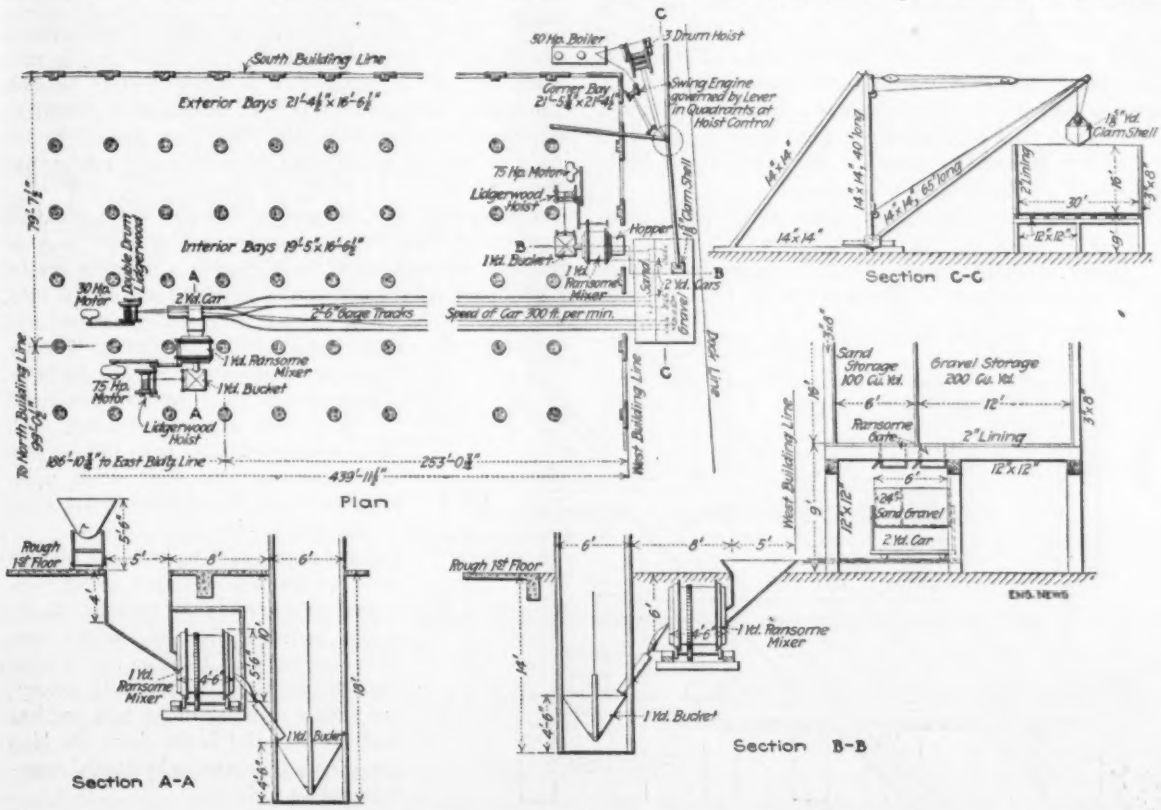


FIG. 7. DETAILS OF CONCRETING PLANT ON AUSTIN-NICHOLS BUILDING

long and 178 ft. 8 in. wide, and has six stories and basement, the story height being 12 ft. 6 in. from floor to floor. It is to be used as a storage warehouse for the large grocery firm, Austin Nichols & Co. Each typical floor bay is 16 ft. 6½ in. by 19 ft. 5 in. and is carried on 2-ft. x 7-in. beams framing into 2-ft. 5-in. x 12-in. girders, which frame into the columns. It was erected on soft foundations, which required timber piles and reinforced-concrete grillages carrying the column footings. It contains 23,000 cu.yd. of reinforced concrete, which required 32,200 bbl. of cement and 1567 tons of reinforcement. There were over a million square feet of lumber in the forms and some 2500 piles used in the foundation, which had 26,400 cu.yd. of excavation. These figures will give some idea of the size of the building.

The contract for the building was awarded on Dec. 1, 1913, and called for substantial completion on Sept. 1, 1914. Work was started on the foundations very soon after the awarding of the contract, but concreting was not commenced until March, 1914. From that time on, speed records in concrete construction were made. The mixing plants were installed as shown in the accompanying Fig. 7. One plant was located at the dock line of the building, and here was placed the storage for the concrete material, which was brought in by barges, and loaded directly above the mixer in sand and gravel bins. Alongside of the storage plant was located a mixer and a concrete elevator. Into this mixer the materials were chuted the material to the mixer. All machinery was electrically driven. With these two plants, 695 cu.yd. of concrete were placed in one 8-hr. day.

The progress in carrying up the building is shown in the accompanying views, Figs. 1 to 6, which give approximate monthly progress on the work. As a rule, one entire floor, including columns, beams, girders and floor slabs of 80,000 sq.ft. of floor space, was concreted in five days at the rate of 16,000 sq.ft. of floor per working eight-hour day, with 600 men working on the building. One set of side-wall forms was used and the stated progress permitted the removal of the first placed side forms on any one floor for the beginning of the next floor by the time the first floor had been finished; that is, the side forms were allowed to stay in about five days. The struts supporting the floor system were, of course, allowed to stay in the regulation three weeks.

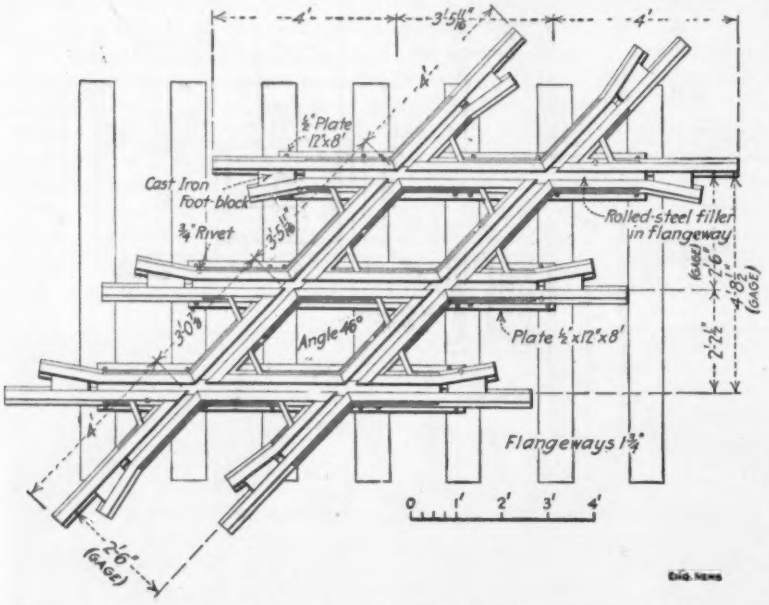
The architectural design of the building, which was made by Cass Gilbert, of New York City, is somewhat unique, as Fig. 6 will show. The grouping of small windows in parallel lines in both directions gives a different appearance to the building than is common in reinforced-concrete buildings. This was permissible, of course, on account of the nature of the building, which did not require any very great amount of natural light.

The entire contract was carried out by the Turner Construction Co., 11 Broadway, New York City, in the contract period of nine months.

Track Crossing for Mixed Gage

In the yards of timber- and tie-treating plants, systems of narrow-gage tracks for the cylinder cars are required to serve the storage yard, treating plant and shipping platforms, and some of these are three-rail or mixed-gage tracks for both the tie-cars and standard-gage cars. The crossings of these tracks are somewhat complicated, and we illustrate herewith the crossing of a mixed-gage track and a narrow-gage track in the yard of the new tie-treating plant of the Louisville & Nashville R. R. at Guthrie, Ky.

The crossing is built of 70-lb. rails, with a ½-in. plate, 12 in. wide and 8 ft. long, riveted under each rail of the three-rail track with ¾-in. rivets, thus making a very substantial construction. These plates are punched with



TRACK CROSSING FOR A MIXED-GAGE (4 FT. 8½ IN. AND 2 FT. 6 IN.) AND NARROW-GAGE (2 FT. 6 IN.) TRACKS IN THE YARD OF THE TIE-TREATING PLANT AT GUTHRIE, KY.; L. & N. R.R.

¾-in. square holes for the spikes. Fillers of rolled or forged steel extend the full length of the straight portion of the flangeways (which are 1¾ in. wide and 1⅞ in. deep), and 1½-in. knees of the same material are fitted at the intersections. Cast-iron footguards are placed at the flared ends of the guard rails. The rails, fillers, etc., are put together with ⅞-in. bolts, there being seven bolts in each end portion and five between each pair of intersections. J. B. Lindsey is Superintendent of Timber Treating Plants.

Liquid Chlorine for Water Treatment at Milwaukee, Wis., is being considered as a substitute for the hypochlorite treatment now employed. The main reason is that in winter, when the lake water is very cold, the chemical reaction with hypochlorite is not the same as in water of ordinary temperature, and as a result it is impossible to avoid taste in the treated water. This causes complaints from consumers, some of whom fear the water is unfit to drink. It is expected that the liquid chlorine treatment will eliminate this trouble, besides saving cost of material, and eliminating the extra labor force employed to apply the hypochlorite. The hypochlorite treatment was used intermittently at first, but is now being used continuously.

New Municipal Asphalt Plant, San Francisco, Calif.

BY B. E. DUNN*

The city of San Francisco has under construction a new plant for the manufacture of asphaltic-paving mixtures, the cost of which will be approximately $57,000. The plant, property and railroad facilities, represent an investment of about $130,000. The capacity will be 180 loads or 320 cu.yd. of wearing surface, or binder, per day.

AGGREGATES—All material is brought to the plant on cars, no teaming being necessary. The sand, rock or gravel is dumped from the cars into a concrete receiving hopper having a capacity of four carloads or 200 tons, from which it is hoisted to a screen and segregated into the proper bin. The elevator has a capacity of 85 tons per hour. The screen is 48 in. in diameter by 22 ft. long, with adjustable jacket. All lime dust is unloaded from the car into a storage room, whence it can be taken as needed (see plan and elevations, Figs. 1 and 2).

STORAGE BINS—As designed, storage bins for the rock and sand are of reinforced concrete, 12 in number, 12 ft. square and 24 ft. deep and have a combined capacity of 1536 cu.yd. Under the storage bins, are two belt conveyors with a capacity of 36 tons per hr., and the material is fed from the bins upon the belt conveyors by special measuring gates (Fig. 3).

SPECIAL MEASURING GATES—These gates can be opened or closed by a shaft gear directly over the belt, which in turn is operated by the belt conveyor. On the shafts are fitted eccentrics, which operate a lever, and by means of a pawl and ratchet the gate is revolved. Each gate has a range of capacity of from 2 to 12 cu.ft. per min., and any mixture of fine or coarse rock or sand can be sent to the dryers.

The material when taken from the belts is hoisted by an elevator and discharged into the uptakes of the dryers. These uptakes are fitted with baffle-plates over which the material slides, coming in contact with and being partially heated by the escaping gases before entering the revolving drying drum.

DRYERS—The drying cylinder is designed with an inclination of 1 on 12. Its shell is ⅜ in. thick, 5 ft. in diameter and 12 ft. long, lined internally with eight 6-in. channels, by which the material is carried up and dropped through the flame, gradually working its way toward the lower end of the drum. Each dryer is fitted with a firing hood, on wheels, similar to that used for an ordinary cement roaster.

HOT MATERIAL BINS—Below the firing hood are two flight conveyors each with a capacity of 36 tons per hr., and designed for hot material. The flight conveyors dis-

*Mechanical Engineer, Board of Public Works, San Francisco.

charge to elevators of the same capacity, which in turn empty into the small storage bins for hot materials above the mixers.

The lime dust is conveyed from the storage room to the hot bins by a flat belt-conveyor fitted with oak strips. The dust is emptied directly upon the belt through a

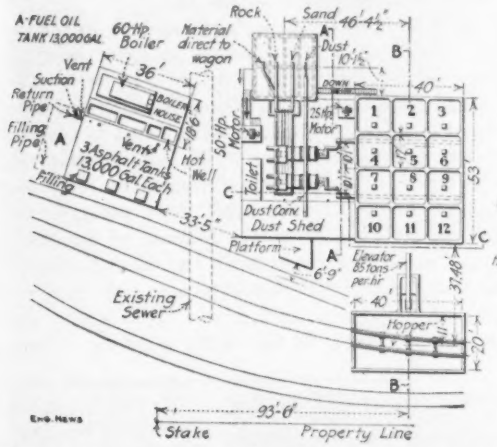


Fig. 1. Plan of the New Municipal Asphalt Plant, San Francisco, Calif.

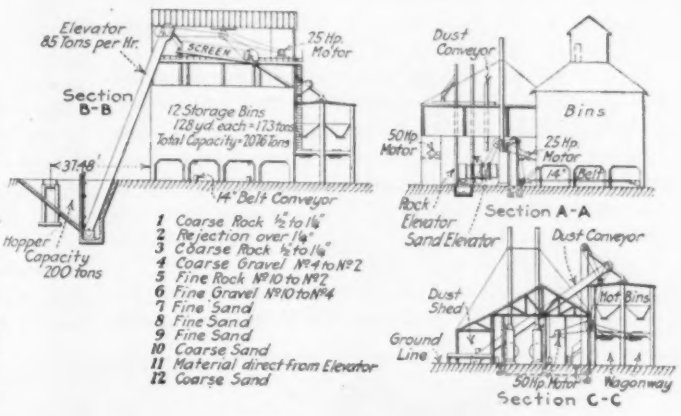


Fig. 2. Sections of New Municipal Asphalt Plant, San Francisco, Calif.

hopper, and all the free dust arising is drawn through a fan discharging into a centrifugal separator, from which it falls back upon the belt.

The hot bins and mixing platform are of reinforced concrete and the dryer shed of steel and corrugated iron.

Measuring Hot Aggregates—Under the hot bins are special measuring boxes for sand, rock, dust and asphalt. Those for sand, rock and dust consist of revolving cylinders open on one side. When the opening in any cylinder is opposite the bin material drops in, and when the cylinder revolves again until the opening is underneath, the material drops out into a hopper. The rock and sand cylinders have a capacity of 3 cu.ft. per dump.

Asphalt Measuring Device—Asphalt is fed to the

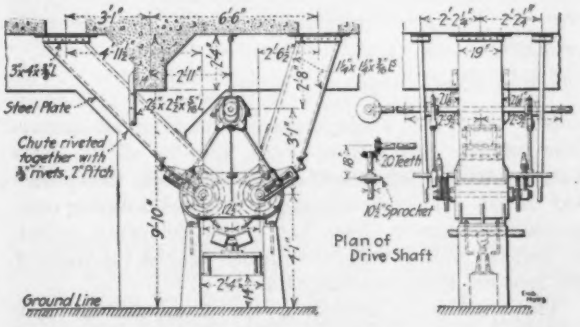


Fig. 3. Measuring Device for Aggregates, San Francisco Municipal Asphalt Plant

mixers in a liquid state and is measured in horizontal cylinders having an internal piston worked by a screw and hand wheel. By changing the position of the piston the size of the chamber and the amount of asphalt used can be controlled. Each cylinder is steam-jacketed and is fitted with a thermometer so that the attendant can easily read the temperature of the liquid before injecting it into the mixer. Asphalt is forced from the measuring cylinder into the mixer by means of compressed air.

Mixing Units—The mixers are 4 ft. 8 in. long x 3 ft. 5 in. wide, with a capacity of 12 cu.ft. per mix. The shafts are 3 in. square and are fitted with 12 sets of steel paddles on each shaft. The shell is ¼-in. steel plate and the heads are of cast iron. While the mixer works on one batch the next batch will be prepared in the hopper directly above. One man can perform all of the operations for each mixer.

Asphalt Heater—A 60-hp. boiler with superheater furnishes steam for heating the asphalt in the tanks, each tank having forty-eight 20-ft. lengths of 1½-in. pipe, with all screwed joints welded. The temperature of the asphalt is controlled by a thermostat operating a valve on the steam line. A steam line also furnishes a means of heating asphalt in the car, which is unloaded by a 2½-in. gear pump, the suction and discharge piping being 3 in. in diameter with an internal ½-in. steam pipe for heating.

An oil-burning system for the boilers is operated with compressed air, which is also used for blowing out the asphalt pipes when closing down. The plant is also equipped with a large centrifugal pump for pumping out any of the elevator pits, should water collect.

All machinery is driven by electric motors, one 50-hp. motor being used to operate the main elevator and screen; one 25-hp. motor to operate the belt conveyors, elevators and dryers; one 25-hp. motor to operate the flight conveyors' elevators and mixers. The air compressor is operated by a 10-hp. slip-ring motor, automatically controlled.

To operate the entire plant, nine men are required: one for the receiving hopper, one in the screen house, one for the dryers, two for the mixers, one for the boiler house, one for the dust shed, one to tend asphalt and dust cars and one superintendent.

The buildings and equipment were designed under the direction of M. M. O'Shaughnessy, City Engineer.

All Paving Records in Galveston, Tex., have been Broken by the city expending more than $200,000 on street pavements during the first nine months of the present year.

A New Rotary Air Compressor

A task which has attracted many inventors is the production of a successful rotary air compressor. For low pressures, such machines are, of course, in very extensive use, the two best known types being the fan blower, suitable for operating against pressures up to a few ounces, and the pressure blower, consisting of two interlocking rotors, which can compress air with fair efficiency up to three or four pounds pressure.

Another type of machine which is becoming more and more common is the high-speed multi-stage compressor, which, while it operates on the same centrifugal principle as the fan blower, is built with an accurately formed blading system like a turbine pump. These machines have to be driven by steam turbines or electric motors to secure high rotative speed and are best adapted to locations where a very large output of air is desired.

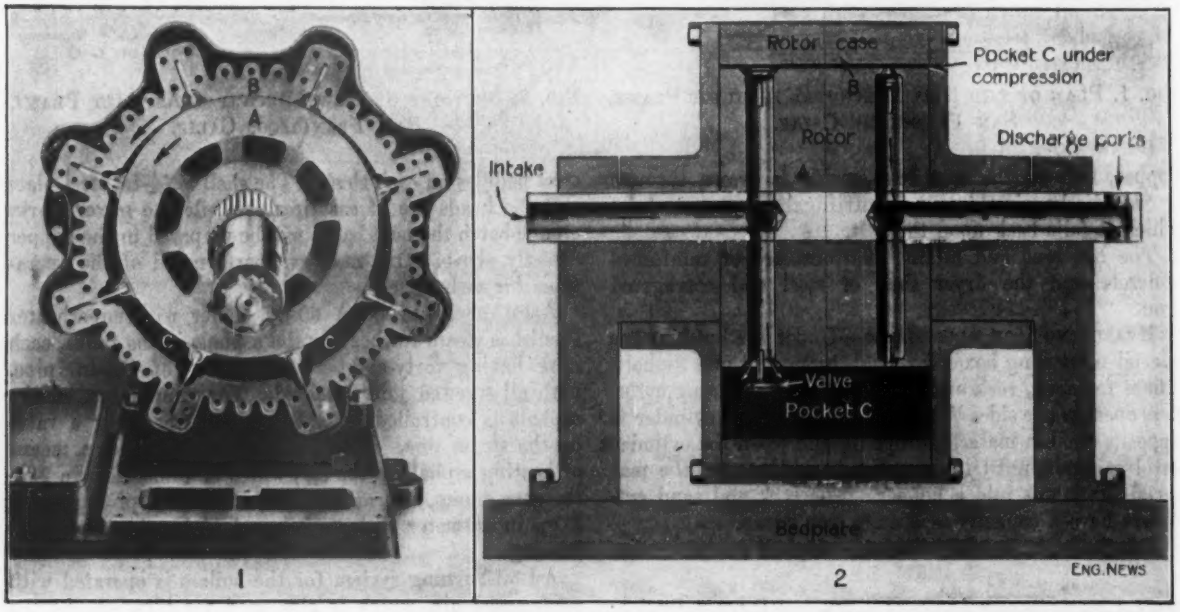
None of these machines, however, meets the demand for a rotary compressor of moderate size which can furnish compressed air at pressures from 10 lb. to 100 lb. per sq. in. and which will be readily portable. The limitations of speed of the reciprocating air compressor and the fact that it is generally an unbalanced machine, requiring substantial foundations, combine to make the positive displacement rotary air compressor a machine of great usefulness if it could be produced and sold at a reasonable figure and were capable of operating at reasonably high efficiency.

There have been occasional attempts to manufacture such positive displacement rotary compressors, but so far as we are aware, none of them have been permanently successful.

We illustrate herewith a new rotary air compressor designed on very novel mechanical lines, which seems to have considerable promise. The rock on which many designers of rotary air compressors have split has been the great friction between the closely fitting rubbing parts. In the air compressor here illustrated the inventor has overcome this difficulty by ingeniously contriving that both the rotor and its casing shall revolve in the same direction and at the same speed. Being on different centers, however, the rotor has an eccentric motion within its casing, and it is this eccentric motion which is utilized to effect the compression of the air.

The rotor shaft is hollow at each end and serves for the intake and discharge of air. It runs in roller bearings and in the machines now built is driven by a belt. The annular space between the two elements is divided into eight compartments or pockets by plates fitted to recesses in the casing and having shoes which bear against the face of the rotor. For each compartment the rotor has an intake and a discharge passage; these passages are radial and connect with the hollow portions of the shaft.

Fig. 1 is a section of the compressor, the rotor being in position for intake at the lower pockets and compression at the upper pockets, and it will be seen that the clearance or dead space in the latter position is very small. Fig. 2 is a diagrammatic longitudinal section. The rotating parts are balanced, and the sliding parts have relatively slight travel and slow motion, thus reducing friction. The pressure in any one pocket during compression is greater than that in the following pocket, so that the sliding vanes are pressed against the walls of the recesses, thus preventing leakage.



A New Rotary Air Compressor

(Fig. 1 is a view of the interior and Fig. 2 is a diagrammatic longitudinal section.)

The machine is air-cooled, the outer wall of each pocket giving a very large radiating surface in proportion to the volume of air under compression, while the entire outer surface of the rotor case (revolving at high speed) forms effective cooling area. Lubrication is effected by a small geared pump.

Each intake valve is operated by means of a lever or lifter, having one end attached to the rotor and the other end (upon which the valve stem rests) riding upon a fixed cam. This construction is shown in Fig. 3. The discharge valves are operated automatically, by the dif-

ference in presure. It is not practicable to operate these mechanically as the time of opening depends upon the receiver pressure, which is not a fixed quantity.

No packing is used between the end faces of rotor and case. The clearance between these faces is very

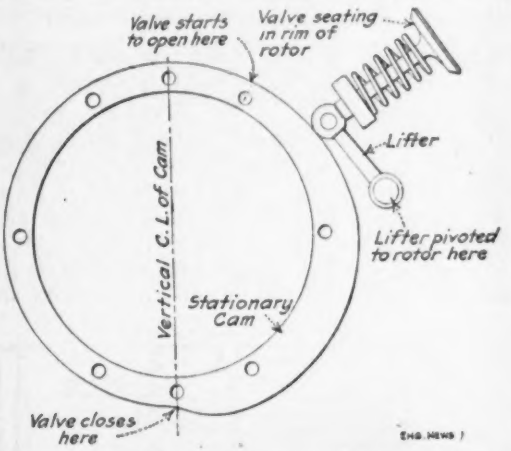


FIG. 3. INTAKE VALVE AND VALVE-OPERATING MECHANISM OF ROTARY AIR COMPRESSOR

small, less than 0.001 in. Oil in very small quantities is fed into the intake to lubricate this surface and helps to seal it. The friction of these surfaces is extremely low because both are revolving in the same direction. The radial movement, or stroke, is small, being only 1½ in. on a rotor of 15-in. diameter.

The machine is at present built in one size only, having a displacement of 86 cu.ft. (or 75 cu.ft. actual delivery) when operating at 100-lb. pressure and at the maximum speed of 400 r.p.m. (giving 3200 compressions per minute). It requires approximately 20 hp. to operate the compressor under these conditions. The weight complete is about 1700 lb. It is claimed that tests thus far made indicate an efficiency at least equal to that of reciprocating compressors of about the same capacity. The rotary compressor is particularly adapted for use as a portable machine on construction work or steel erection, and in mines, quarries and industrial plants. One compressor has been in use for over a year.

This compressor is the invention of W. A. Hatcher, and is being manufactured by the Wernicke-Hatcher Pump Co., of Grand Rapids, Mich.

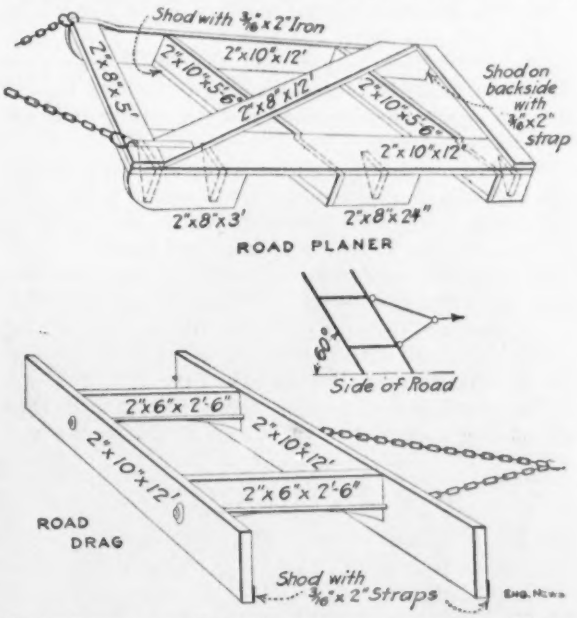
Road Maintenance in Minnesota

Under the road laws of Minnesota, it is the duty of the county commissioners of each county to maintain all state roads within the county, in accordance with the rules of the State Highway Commission, and 20% of the state-aid allotment must be expended for that purpose, with the due proportion of the county funds.

The maintenance may be done under the road-patrol system, the maintenance-section system or the road-drag system. The systems in question are outlined as follows in the rules prepared under the direction of Geo. W. Cooley, State Engineer, and John H. Mullen, Deputy Engineer of Roads:

ROAD-PATROL SYSTEM—One man to be appointed for a 5- to 7-mile section of road, and to be employed continuously from the opening of the season until final freeze-up. He will be furnished with shovel, rake, and such other hand tools as are necessary and also a wheelbarrow to cart surfacing material to fill holes, etc. The duties of the patrol will be to keep ruts from forming, remove loose stones from roadway and to keep surface of road in good condition. He will also be required to keep lines of drainage open and to keep weeds cut along the road. This system is applicable to macadam and well built gravel roads.

MAINTENANCE-SECTION SYSTEM—The state roads in a county to be divided by the County Board into sections of 20 to 30 miles (not necessarily one continuous stretch of road). The section to be in charge of a foreman, hired for the season, commencing as soon as work can be effectively done in the spring. This section foreman should be required to furnish hand tools and a team and wagon every working day, and the county to furnish him with a light grader, a road drag,



ROAD PLANER AND DRAG RECOMMENDED FOR ROAD MAINTENANCE WORK BY THE STATE HIGHWAY COMMISSION OF MINNESOTA

slush scraper and plow. The duty of the maintenance-section foreman would be to keep lines of drainage open and weeds cut and to keep the surface of road in best possible condition at all times. The County Board should also authorize the foreman to enter into agreements with residents along the road to drag sections of it after very heavy rains, and also to employ extra men and teams as the occasion might require, but with a limit as to the expense incurred in this manner each month. This system is recommended to be adopted in most cases, as it will meet almost any condition.

ROAD-DRAG SYSTEM—A superintendent of dragging to be appointed by the County Board, who shall be given authority to contract with residents along the state roads to drag the same after each rain or whenever ordered by him. This superintendent also to have available a road grader with authority to employ an engine or teams to operate the machine when occasion requires. He should devote all his time to directing the work of general repair and maintenance, and see that the contracts for dragging are properly executed. Also to see that drainage lines are kept open and to arrange for cutting weeds along the state road. This system is especially applicable to the prairie and gumbo sections of the state.

ROAD DRAGS—A large amount of road maintenance by dragging is done in Minnesota, and a pamphlet issued by the State Highway Commission shows the recommended forms of drags. These are shown in the accompanying cut. It is stated that the drags which have proved most satisfactory are the home-made road-planer and the King road drag, and that the consistent use of these will insure a good road surface at all times.

New York Rapid Transit Railway Extensions*

By F. Lavis†

VI--Sewers, Pipes and Conduits

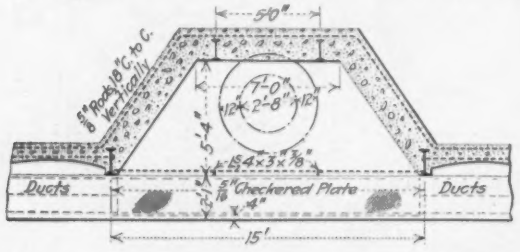
Electric Conduits

Four-way vitrified ducts with round holes (3½ in.) are used almost entirely for electrical conduits in the subway; they are located in the side bench walls, as shown in the various cross-sections, usually a double tier 5 high, making 40 single ducts.

The specifications require that the outside dimensions (of 4-way ducts) be not less than 9¼ in. or more than 10 in. with square outer lines and that the outside walls and webs be ¾ in. thick.

A linked mandrel is used for laying and the joints are wrapped with muslin wraps soaked in cement grout. The mandrel is arranged so that the back part of it holds the joint last made, while the forward end holds the joint being made. One or two other forms of wraps have been tried but with little success. The whole bank of ducts is usually laid up, then the outer face of concrete, and top of the bench wall put in place. This is usually done before rodding to insure the stability of the duct bank.

Wherever it is at all possible, connections are made from all splicing chambers to the street, so that cables may



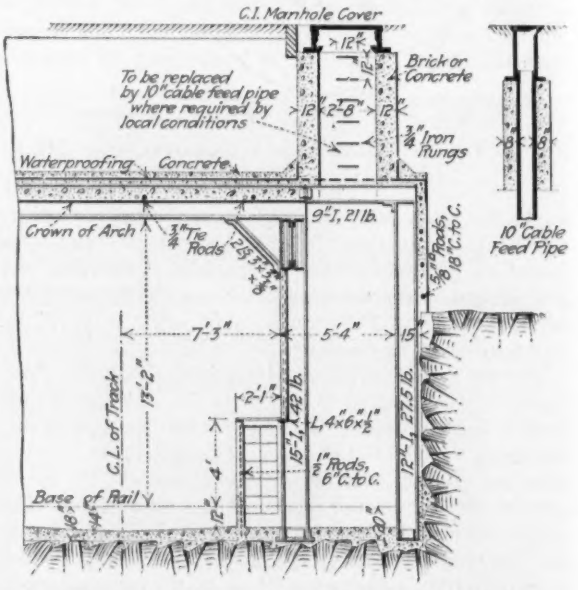


Fig. 24. Horizontal Section of Subway Wall at Cable Splicing Chamber and Vertical Section through Manhole

be placed or withdrawn from the street surface, on account of the difficulty of handling them in the subway after operation has been started. Where space allows, a regular manhole is built from the splicing chamber to the street surface, but where this is not possible a 10-in. feed pipe is built in. The splicing chambers are, of course, set back and project outside the ordinary cross-section, a typical form being shown in Fig. 24.

The prices for these conduits as shown by contracts already awarded are approximately 10 to 15c. per lin.ft. of single duct.

Existing Underground Structures

The construction of the subway, of course, necessitates many changes in the existing underground structures, such as sewers, water and gas pipes, electric-wire conduits, etc. The isometric drawing, Fig. 25, shows conditions at Fulton St. and Broadway on the line of the present subway as they existed 24 years ago. Since that time very great additions have been made to the underground street piping. The picture, however, gives some idea of what is found at many street intersections, though, as a matter of fact, the general appearance of one of these cross streets in the down-town section is more that of an intricate and confused jumble of pipes and cables of all descriptions instead of the orderly appearance of the drawing. Fig. 30 shows part of the plan of the intersection of Prince St. and Broadway and is fairly typical of conditions in the lower part of the city.

It would seem at first thought that certain large trunk sewers and other important subsurface structures might have considerable influence on the location of the rapid-transit lines, but it has generally been found easier or less costly to change these than to change the position of the subway. This latter, of course, is usually located as near the surface as possible, and any change would mean lowering it, which would be undesirable from the standpoint of those who have to use it, and, of course, would mean increased excavation with proportionately greater expense, so that generally speaking, the subway is located regardless of any of these structures and these latter moved if necessary. There are a few instances where it has not been practical to move some of the large trunk sewers, and these will be noted further on.

This work connected with the changes, etc., required in the existing underground structures is all taken care of by two divisions, each covering the whole city in its own special department. One under C. N. Green has charge of the relocation of all pipes, conduits, etc., and the other under L. D. Fouquet has charge of all the sewer relocation, design and reconstruction. The importance of this part of the work may be gathered from the fact that there are employed in these two departments alone, taking

*Copyright, 1914, by F. Lavis.
†Consulting Engineer, 50 Church St., New York City.

care of work in a way entirely outside of the main construction, some 150 engineering assistants, the changes in the sewers alone involving an expenditure of $6,000,000 to $7,000,000 and the construction of some 60 miles of new sewers.

GAS MAINS—One of the most important developments in taking care of the pipes, etc., on the new work has been the bypassing of all the gas mains, that is, the construction of new pipes for gas, on the surface of the street and the stoppage of the flow in the pipes underneath before commencing the excavation. This, of course, involves also new temporary house connections as well, but the danger of the accumulation of gas underneath the decking is thereby eliminated. The very great danger from this source was demonstrated by the recent explosions at 23rd St. and 5th Ave. (ENG. NEWS, Mar. 12, 1914), which pipe tight even when they are undisturbed, but when they are moved in excavating and hung up on the timbering, some joints are sure to be strained and begin to leak.

"All gas mains are, therefore, 'killed' where they would be underneath a closely decked street, except in rare cases where small transverse cast-iron mains are replaced under the decking by wrought-iron pipes with screw connections. A temporary system of wrought-iron pipes or bypasses for gas distribution is laid in the gutters and connected with the live mains in the transverse streets and the house and street-lamp services are transferred from the cast-iron mains below the street surface to the temporary system. There is then no live main or pipe containing gas below the street surface." (Figs. 26 to 29.)

"An 8-in. gas pipe broken off in the excavation might, under existing conditions, deliver 1000 cu.ft. of gas per

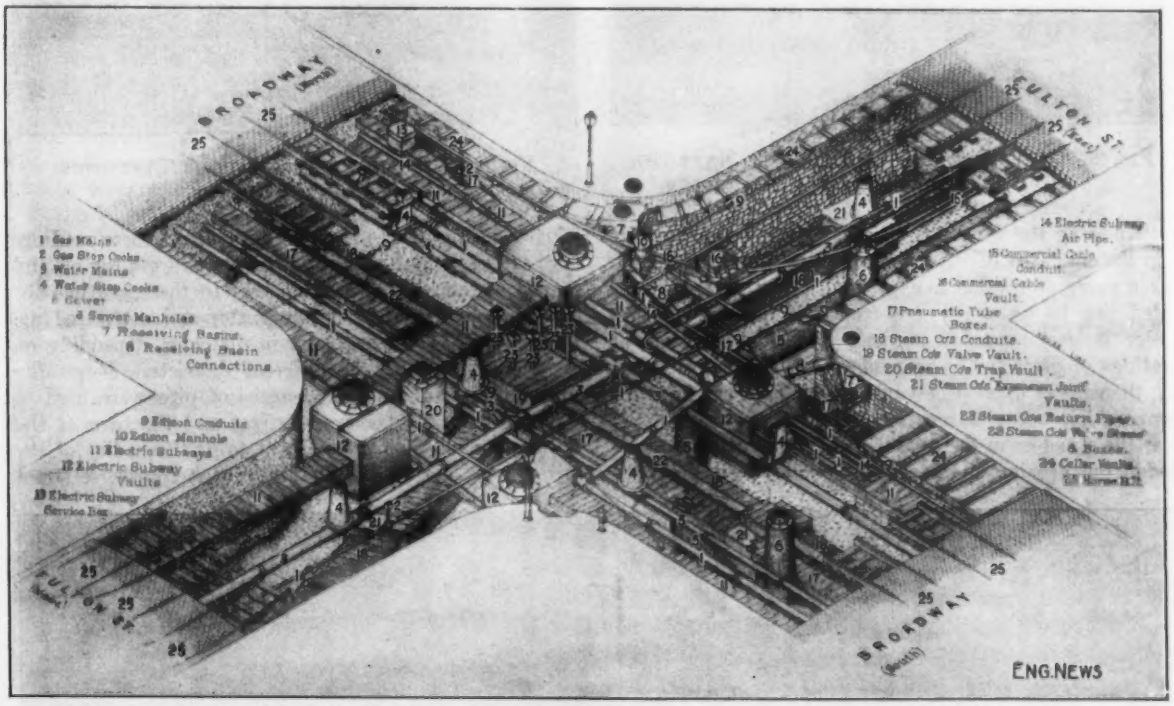


FIG. 25. ISOMETRIC VIEW OF UNDERGROUND PIPING AT THE INTERSECTION OF BROADWAY AND FULTON ST. IN 1890

while generally attributed by the public press to the subway construction, were caused if at all only very indirectly by this work. The following description of the method of dealing with the gas mains is contributed by C. N. Green.

"The present specifications for subway construction call for the street to be planked or decked over in the business sections or where traffic is heavy, so that business may be carried on as usual and with as little inconvenience to the public as possible. This decking then forms a temporary street surface under which the excavation is carried on. In time dirt and the sweeping of the street make the decking tight and prevent a circulation of air that would free the excavation of gas if a main should leak.

"Cast iron is used for gas and water mains when they are laid underground for the reason that it lasts much longer under such conditions than wrought iron. It is difficult, however, to keep the lead-calked joints of such

minute. A 10% mixture of gas and air will perhaps not always produce a maximum explosive effect, but this is assumed for convenience and is very near a maximum. This would make 10,000 cu.ft. of explosive mixture per minute. A subway cut 25 ft. deep, 60 ft. wide, would contain 390,000 cu.ft. in a city block, so that theoretically in 39 minutes the block would be filled with an explosive mixture. This, of course, would not be absolutely true as the gas would not diffuse itself with such rapidity and the mixutre would be higher in gas near the break in the main and perhaps be too low in gas at the farthest point to explode, if the mixture should explode, however, the gas would burn where there is an excess and probably set fire to the timber with results as disastrous as the explosion itself.

"Gas mixed with air forms a very explosive compound which only needs a spark to ignite it. This spark might be furnished by the underground trolley of the surface

railway, by one of the numerous cables exposed during the excavation, by a lighted match thrown away, by fire engines, by the shoe of a horse, or by blasting, etc. The violence of such explosions has been frequently shown when manhole heads have been blown into the air, and by numerous sewer explosions which have occurred in the last few years. Philadelphia and Boston had examples in the construction of their subways and various minor instances have attested to the power of such a mixture.

FIG. 26. A TEMPORARY GAS MAIN RUN NEXT THE STREET CURB

"Knowing the danger from gas, both the gas company and the engineers of the Public Service Commission have taken every precaution to avert it. It was, therefore, decided not to leave any cast-iron mains, carrying gas, under the decking unless properly ventilated by means of gratings or protected by watchmen. Where mains crossing the subway excavation could not be cut out of service temporarily, wrought-iron pipe bypasses were to be built over the street or in the case of small pipes carried across under the decking. All connections between the cast-iron mains and the wrought-iron bypasses were to be carried far enough back into solid earth to avoid the danger of breaking off the pipe if a slide or cave-in should occur.

"In mains to be 'killed,' the flow of gas was first stopped by inserting bags in the pipe and readings were taken to see if the pressure prescribed by the Public Service Commission could be maintained. The pressures were

FIG. 27. OVERHEAD GAS MAIN AT LEXINGTON AVE. AND 112TH ST.

taken continuously for several days and if these readings were satisfactory the longitudinal mains were cut off and capped at intervals of two blocks. In the meantime the bypass pipes were laid in the gutter and connected up. These were 6, 8, 10 or 12 in. in diameter, depending on the requirements of the different districts. Depending on conditions, one or two lengths of pipe were used to carry back in the transverse street and the turn at the curb was made with a pipe bent to fit the radius of the curb corner, Fig. 26. The pipes in each transverse street

FIG. 28. OVERHEAD GAS MAIN ON LOWER BROADWAY

were then cut and capped about 10 ft. back of the sheeting line on both sides of the proposed excavation. Connection was then made with the largest pipe underground on each side of the street and the bypass continued underground across the transverse street.

"Generally there are from one to five pipes on each side of the transverse streets. Where there is more than one

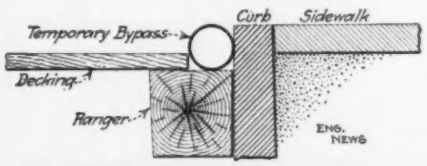


FIG. 29. TYPICAL METHOD OF PLACING GAS MAIN AT CURB

pipe on the same side of the street, each is connected back of the caps with a 1½-in. circulation connections, the vertical legs of which are tapped into the top of the pipe.

"In laying the first bypasses little attention was paid to the necessity of keeping the tops of the pipes level with or below the curb. As a consequence, numerous accidents occurred, due to persons slipping or tripping over the pipe. In one instance where the pipe did not lie close to the curb, a boy's leg was broken by being caught between it and the curb. Now all pipes are laid close to the curb, with the top not higher than the curb even if necessary to remove the gutter stones, and the remaining space is filled with concrete.

"Extra heavy wrought-iron pipe has been used generally, so that when the bypasses are moved the pipe can be used to relay the cast-iron mains over the subway. The gas company has found this desirable, as the vibration from the passing trains loosens the calking in cast-iron pipes.

"In Lower Broadway from Canal St. south are two mains 16 and 20 in. in diameter, respectively, supplying the lower part of the city. These mains were bypassed during the building of the subway from Vesey St. to Canal St. Wrought-iron pipes with flanged connections were laid about 14 ft. above the sidewalk. The trestle bents were so placed as to avoid entrances and interfere with business as little as possible. At cross streets where trestle bents could not be erected, the pipe was trussed with wire rope anchored to the pipe with clamps.

"In 138th St. are one 16-in., one 20-in. and one 24-in. gas mains forming a crosstown connection between the works and the lower west side of the Bronx. As these were within the sheeting lines, they were killed, and to take their place two 24-in. riveted steel pipes were laid on trestles, one on each side of the street.

"In various locations are large feeder or pumping mains crossing the line of the subway, and these mains generally were bypassed overhead, giving about 14 ft. clearance for the street cars and other vehicles. A description of one would be typical of all. Fig. 27 shows the bypass for the 36-in. main crossing Lexington Ave. at 112th St. The bypass pipe is a 30-in. wrought-iron riveted pipe carried on two gallows-frame supports back of the building line in the side street. Between these frames the pipe is suspended from two wire ropes carried over the gallows frames and each anchored back to a deadman. The deadman consisted of an inclined I-beam carried well below the street surface and its lower

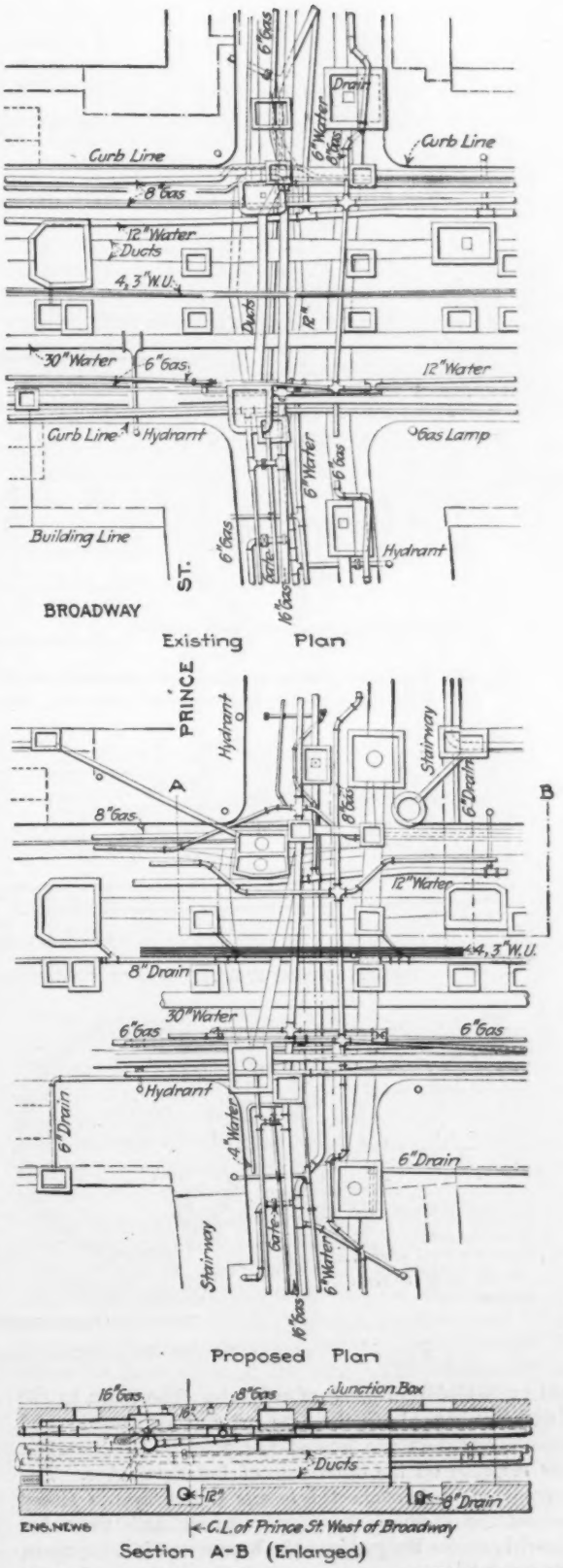


FIG. 30. A TYPICAL REARRANGEMENT OF UNDERGROUND PIPING AT A STREET INTERSECTION, OLD AND NEW PLANS OF UNDERGROUND PIPING AT BROADWAY AND PRINCE ST.

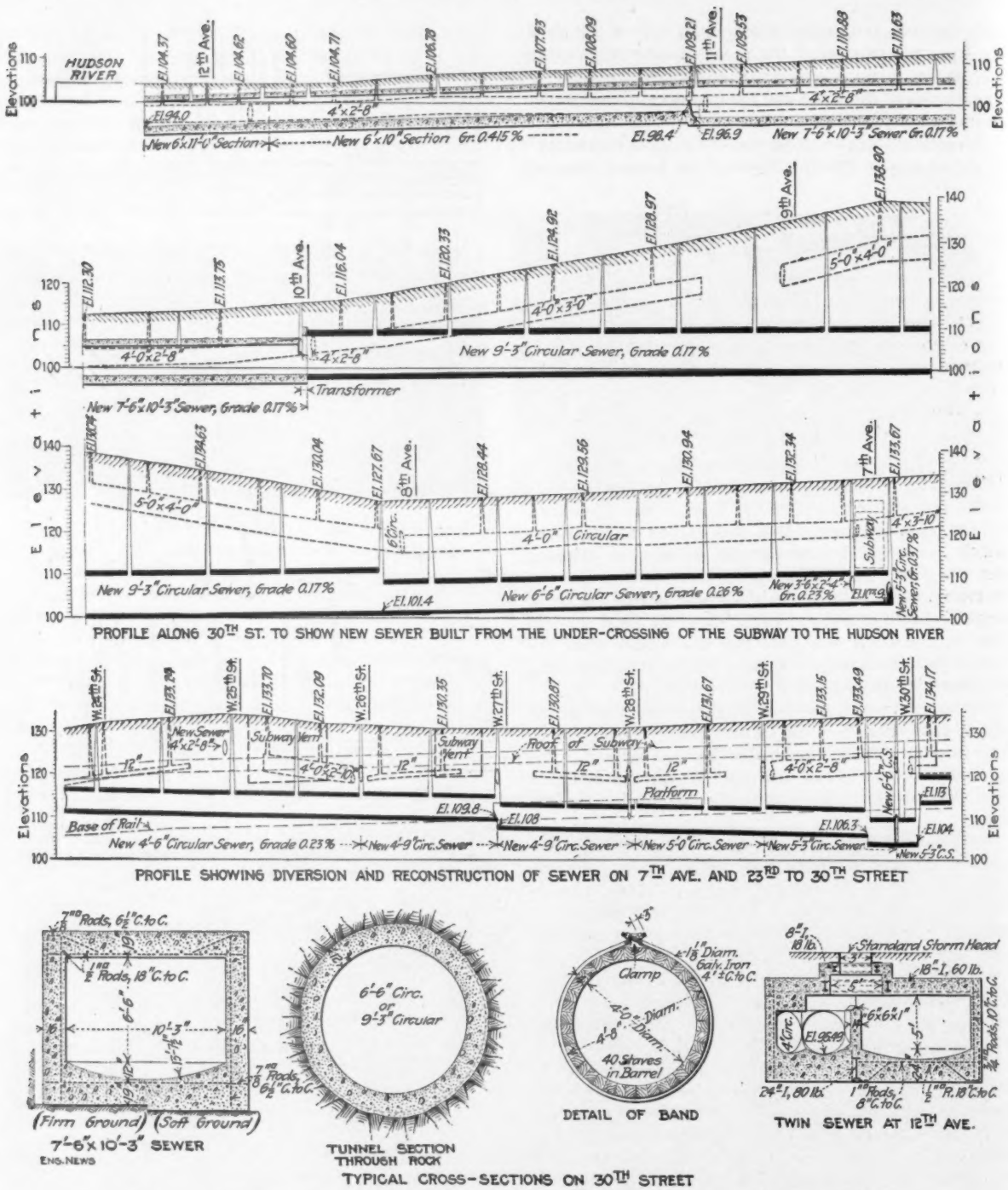

PROFILE ALONG 30TH ST. TO SHOW NEW SEWER BUILT FROM THE UNDER-CROSSING OF THE SUBWAY TO THE HUDSON RIVER
PROFILE SHOWING DIVERSION AND RECONSTRUCTION OF SEWER ON 7TH AVE. AND 23RD TO 30TH STREET
7'-6"x 10'-3" SEWER
TUNNEL SECTION THROUGH ROCK
DETAIL OF BAND
TWIN SEWER AT 12TH AVE.
TYPICAL CROSS-SECTIONS ON 30TH STREET

FIG. 31. TYPICAL SEWER RECONSTRUCTION WORK ON 30TH ST. AND SEVENTH AVE.

end embedded in a block of concrete. The main in the street was bagged off, the pipe cut and a three-way and valve inserted in the line of the pipe. This operation was repeated on the other side of Lexington Ave. The bypass was then connected to the three-ways on either side of the avenue, the bags removed and the valve closed to throw the gas into the bypass and kill the main underground.

"The cost of bypassing service mains, using 6- or 8-in. wrought-iron pipe laid in the gutter, varies but little from $50,000 per mile of street bypassed. The distribution mains requiring 16- to 30-in. bypasses in general run across the island from the east to west, thus crossing most of the subway lines nearly at right angles. The cost of carrying a distribution main across the street on trestle may vary from $1000 to $10,000, depending on local conditions. The average cost, however, should be about $2500.

"After the construction of the subway and the restoration of the underground pipe, the bypasses are removed and the street restored to its original condition."

SEWERS—The work of the department in charge of the

necessary sewer relocations commences as soon as a new route is proposed, as, although the subways are generally located with little regard for existing subsurface structures, minor changes and adjustments in elevations and gradients are quite often found to be desirable. General studies of the sewer situations are, therefore, necessary from the beginning. The sewer changes are worked out in consultation with the city authorities and the plans are made part of the contract drawings. This same department makes the preliminary studies, final plans and supervises construction.

Generally the existing sewer line is located in the center of the street. The construction of a subway therefore usually involves its complete elimination, and the substitution of two lines, one on either side. In Manhattan also the main trunk sewers and intermediate main lines are generally located in the cross streets running east and west to the Hudson or East River. The construction of a subway on one of the main north and south avenues therefore cuts these all off, as they are nearly always located below the level of the roof.

the surface of the street was raised 5 ft. to enable the subway to pass over the top of the sewer.

Generally speaking, however, the large sewers where they have been encountered have been passed under the subway by means of siphons, and while this is not generally considered desirable for sewers, those so far built seem to be working satisfactorily. The general principle on which they are designed is much the same for all; that is, a comparatively small pipe for the so called "dry-weather" flow, with one or two larger pipes for the storm flow. The plan and section shown, Fig. 32, of the siphon at 110th St. and Lexington Ave. is quite typical. Most of the siphons have been built with easy slopes for the drop or rise, but in one instance in Brooklyn, at Hudson St., perpendicular raises were required on account of the cramped conditions. In this case a wide, very shallow additional safety overflow was provided over the roof of the subway.

Cross-sections of particular forms of construction not usually met with in sewer work, but required by the exigencies of limited clearance in many cases in con-

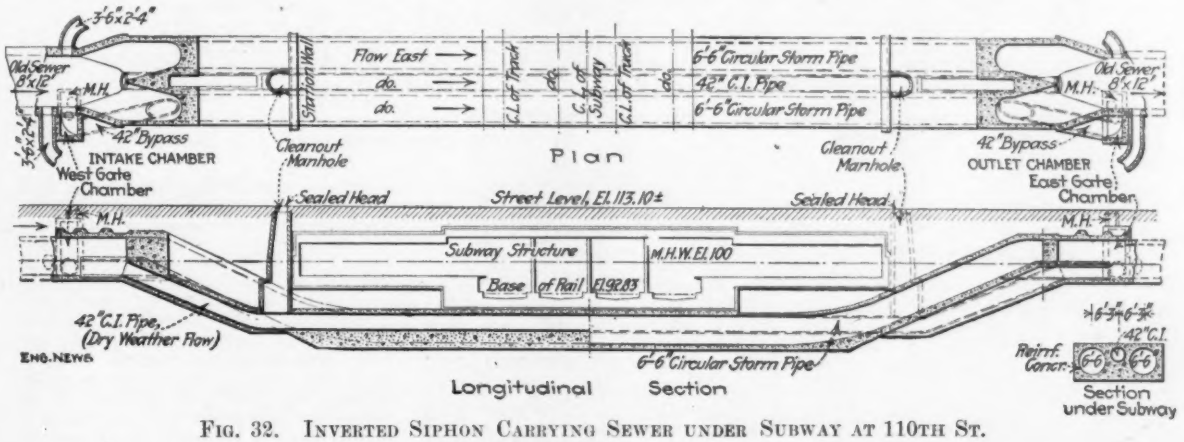


FIG. 32. INVERTED SIPHON CARRYING SEWER UNDER SUBWAY AT 110TH ST.

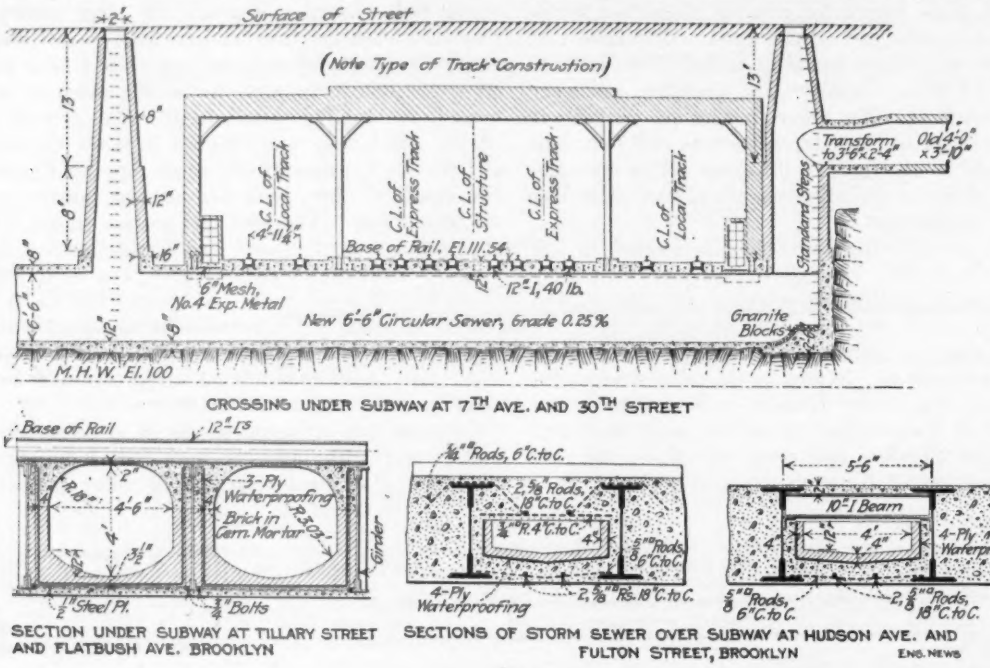
On what may be referred to as the down stream side of the avenues the problem is usually comparatively simple. A new line is laid between the subway and the buildings, connecting at the cross streets to the existing sewers, which, however, of course only get part of their former flow. On the up stream side, however, not only do the buildings adjacent to the subway have to be taken care of, but also the flow from the cross drains which have been cut off. The least important of these cross sewers are, therefore, collected in a main laid parallel to the subway and carried to some convenient crossing point, where either the subway can be lowered, to pass the sewer over the top, or where topographical conditions permit the sewer to go under and continue with sufficient fall to the point of discharge into the river. The conditions at 30th St., New York, are quite typical of this condition, Fig. 31. The construction of this one line, giving a new outlet all the way to the North River, cost over $500,000.

In a very few instances there have been large trunk sewers which could not be changed and which have necessitated a very considerable adjustment of the gradients of the subway to enable the line to pass them. At Canal St. and Broadway and at Duane St. and West Broadway, Manhattan, the subways were depressed to go under the sewer, while at Brook Ave. and 138th St., in the Bronx, nection with the subways, are shown in Fig. 33. An interesting temporary expedient was adopted on the Fourth Ave. subway in Brooklyn. At one place on this line it was necessary to take care of quite a large volume of sewage until such time as a new relief trunk sewer could be built by the city. The subway at this point was built for six tracks, so one whole bay at one side for a length of 2200 ft. was isolated by being walled in, waterproofed and turned into a sewer until such time as the relief sewer was built.

The Duane St. sewer in Manhattan is typical of certain conditions which have to be met and where advantage was taken of the peculiar topography of New York and the long established habit of drainage into the rivers on both sides of the city. The drainage from Centre St., through which the so called Loop line runs from Duane to Delancy, was to the East River. This was cut off by the construction of the Loop, which was too deep to permit the construction of the sewer underneath, so a deep-level sewer was built under the original subway, through Duane St. to the North River, thus reversing the flow from what was formerly the up-stream side of Centre St. It is this new sewer that the Seventh Ave. route in West Broadway has to go under, as referred to above.

The numerous questions which come up in connection

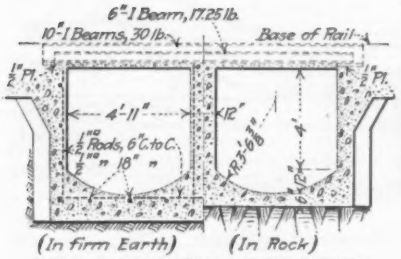
with the relocation of these existing underground structures are only hinted at above, but enough is given to show at least generally the importance of this part of the work and the skill and ingenuity often necessary in working this out.


Surface of Street
(Note Type of Track Construction)
C.L. of Local Track
C.L. of Express Track
C.L. of Structure
C.L. of Express Track
C.L. of Local Track
Standard Steps
Transform. to 3'-6" x 2'-4"
Old 3'-9" x 3'-10"
Base of Rail, El. 111.54
12"-1,40 lb.
6" Mesh, No. 4 Exp. Metal
New 6'-6" Circular Sewer, Grade 0.25%
Granite Blocks
M.H.W. El. 100
CROSSING UNDER SUBWAY AT 7TH AVE. AND 30TH STREET

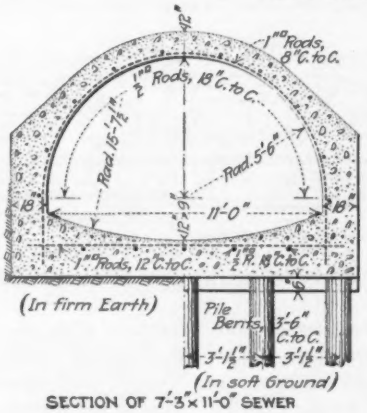
SECTION UNDER SUBWAY AT TILLARY STREET AND FLATBUSH AVE. BROOKLYN

SECTIONS OF STORM SEWER OVER SUBWAY AT HUDSON AVE. AND FULTON STREET, BROOKLYN

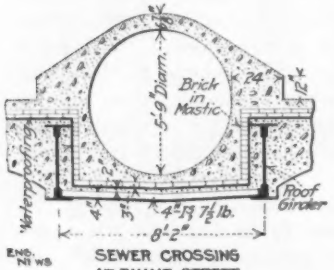
ENG. NEWS



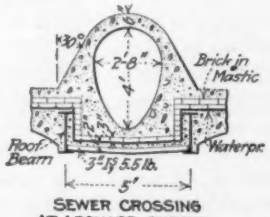
SECTION OF TWIN SEWER UNDER SUBWAY



SECTION OF 7'-3" × 11'-0" SEWER



SEWER CROSSING AT DUANE STREET



SEWER CROSSING AT LEONARD STREET

FIG. 33. TYPICAL CROSS-SECTIONS OF NEW SEWERS

Gas- and Electric-Service Standards of the Wisconsin Railroad Commission have recently been revised in the light of five years' experience under the first ones (see "Engineering News," Oct. 8, 1908). The utility service has steadily improved during these years and the revisions are aimed more at means than ends.

For gas meters the new rules allow 2% inaccuracy but the test flow is required to be "standard" instead of 6 cu.ft. per hr. per light capacity, although this figure is still a recognized standard. Gas meters are to be tested each 48 months instead of 36 and consecutive test runs must agree within ½%. The test records to be kept are specifically outlined. Complaining consumers may have meters tested once in six months. Formerly the Commission tested meters for a flat fee of $2; now a scale is established of $2 to $8, depending on capacity. The monthly average of calorific value must be not less than 600 B.t.u. per cu.ft.; a minimum of 550 is fixed. Large producers (over 20 million cubic feet per year) must determine calorific value on three days a week. The minimum outlet pressure is raised from 1½ to 2 in. of water; the maximum is 6 in., but not over double the minimum at any outlet. Gas must contain no more than 30 grains of sulphur and only a trace of hydrogen sulphide. Demand for pressure records is made more specific by requiring use of portable graphic recording meters. Companies are not now required to report all complaints monthly, public inspection of complaint record being substituted.

The earlier rules on electricity supply were made few and simple on account of the unsettled condition of the industry. The new rules show marked changes. The limit of accuracy of electricity meters is made "4% between ⅛ and full connected load" instead of at "light load" and "full load." The old rule for installation tests merely provided for adjustment and test on installation; a new rule gives details of testing method. The rules for periodic tests and records are made more detailed. Tests of complainants are to be made not more than once in six months. The fee for Commission test is raised from $2 flat to $2-$8. Bills must give actual meter readings and dates. The power-station records must show starting and stopping of equipment, indications of principal instruments, interruptions of service and their time, duration and cause. In cities of over 1500, a standard voltage must be adopted for constant-potential lines and maintained within 3% during lighting hours. In other hours and on power lines, the variation may be 10%. Voltage surveys must be made frequently enough to satisfy the Commission of meeting the variation requirements. Customers must be informed of conditions under which efficient service is to be secured and be assisted in securing lamps and appliances best adapted to the service.

Nozzle Testing, Fitchburg, Mass., Sewage Treatment Plant*

The problem of finding an efficient method of uniformly distributing sewage over the surface of a rock filter is one which has been the subject of extensive studies.† Severe winter conditions preclude the use of any traveling distributor, and the method generally employed is the discharge in the form of a spray through some type of fixed nozzle operating under a varying head.

No nozzle has yet been used that will give a uniform distribution in practice. Some are better than others, and it has been the purpose to test the types of nozzles now on the market, and from the result of these experiments to select a nozzle and design a tank, which combined, will effect the most uniform distribution. These tests to the first of May, 1914, numbered over 1000.

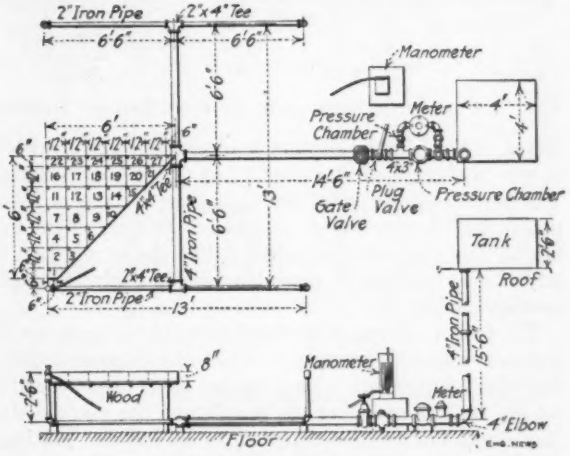


FIG. 1. NOZZLE-TESTING APPARATUS, SEWAGE-TREATMENT PLANT, FITCHBURG, MASS.

The plant for testing the various nozzles was set up in a garage connected with the sewer department building. The first experiment showed that satisfactory results could not be readily obtained by studying the discharge of a single nozzle; consequently, the plant was so arranged that the distribution would be analogous to that obtained in practice if the nozzles were placed on the corners of squares or interlocking hexagons whose sides were 13 or 15 ft.

Fig. 1 shows the apparatus when set up to study the distribution of nozzles set on the corners of a square with a side of 13 ft. The pan and distributors were later extended to study the distribution of the same nozzles spaced 15 ft. Only those nozzles designed to throw a spray over a square area were tested with this form of apparatus.

Three nozzles on the apices of an equilateral triangle are sufficient to show the distribution as effected by nozzles placed on the apices of interlocking hexagons. Fig. 2 shows the apparatus as used when the nozzles were considered as placed on the apices of hexagons with sides of 13 and 15 ft. Only those nozzles which throw a spray over a circular area were tested with this scheme of spacing.

For determining the head under which a nozzle operates, the mercury pressure gage, shown in Fig. 1, was later replaced by a water column, which proved far more satisfactory. It was found that for measuring the actual discharge in gallons of a given nozzle at a given head, it was more accurate to plug all risers except one and insert a small meter in a 2-in. distributor, than to use the large meter for all nozzles. Consequently, the large meter shown in the sketch was removed. The piping was arranged in all cases as symmetrically as possible, and every precaution was taken so that the pressure on all nozzles was equal.

For collecting the discharge and studying the distribution of those nozzles designed to throw a square spray, a 45° galvanized-iron pan representing one-eighth of a square inclosed by the nozzle was used. The pan was divided into sections as shown in Fig. 1. Each section is drained by ½-in. pipe about 3 in. long soldered to one corner and closed with a rubber stopper during the test.

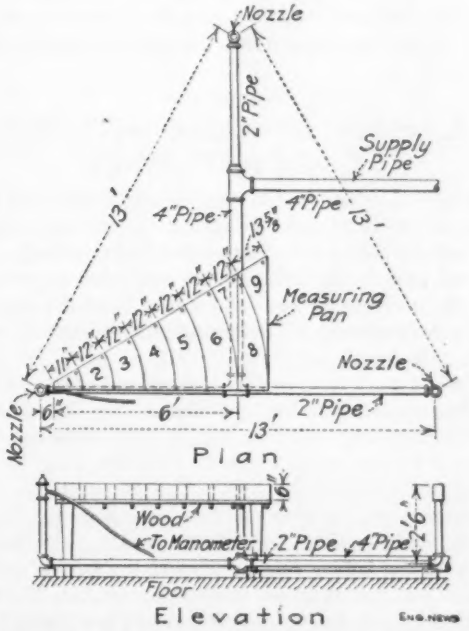


FIG. 2. TESTING APPARATUS FOR CIRCULAR NOZZLES

The whole pan rests on a wooden base and can be moved readily.

For collecting the discharge of those nozzles which throw a circular spray, the pan shown in Fig. 2 was designed. It was later divided into smaller sections along the line of radii drawn from the center to the desired points on the arcs. It covers one-twelfth of the total area dosed by each nozzle when the hexagonal spacing was used.

Using Fig. 1 as an illustration, a typical test was conducted as follows: The tank on the roof was filled with city water by means of a hose and, with the water still running, the pan unstoppered, and the plug valve open, the gate valve was regulated to give the desired head as indicated by a water column.

The plug valve was then closed and the pan stoppered.

*From the Seventh Semiannual Report of the Sewage Disposal Commission of Fitchburg, Mass.; for description of Fitchburg Sewage Treatment plant, see "Engineering News," June 5, 1913, p. 1176.

†For a description of the sprinkler testing apparatus used at the Massachusetts Institute of Technology in 1907, see "Engineering News," Jan. 9, 1908, p. 28; Aug. 20, 1908, p. 199.

At a noted time the plug valve was opened quickly and the water allowed to discharge through the nozzles under constant head for 5 or 3 min. At the end of the time decided on the plug valve was closed quickly and the amounts collected in the various pan sections measured with a 1000-c.c. graduated cylinder.

The discharge of each type of nozzle was determined separately with a small meter, as noted previously. Consequently, the amount collected in the pan should be one-eighth of the total discharge for any particular head. Any difference at low head would be due largely to eccentricity to the nozzle spindle or variation in the deflecting cone, while at higher heads, the effect of overlapping would be apparent. It was for the purpose of best studying this overlap that the battery of nozzles, instead of the single nozzle was used.

The amounts collected in the pan sections and the meter readings were recorded on spaced blanks and all subsequent calculations were made from these data. Duplicate or triplicate tests beginning at 2-ft. head and ending with 9-ft. head constituted a series.

Two makes of square type and two of circular type of sprinkler were studied. The work was discontinued through the cold weather, but was resumed in early spring, when a special nozzle designed by the department was studied.

Ladder Dredges with Side Ladder Frames

A type of ladder dredge which is used extensively on the Ohio River, is peculiar in having the ladder frame carried at the side (and clear of the hull) instead of in a central well in the hull. These machines are employed largely in obtaining sand and gravel from the river bed, and are frequently of rather rough-and-ready construction.

The left-hand view, in Fig. 1, shows one of these dredges built by the Missouri Valley Bridge & Iron Co., of Leavenworth, Kan., and now in use by this company on its contract for the construction of dam No. 14 in the Ohio River at Woodland, W. Va. The arrangement of the machinery, etc., is shown on the plan, Fig. 2. The hull is 24x100 ft., and of very shallow draft. The deck extends on the ladder side to support the ladder and protect it from gravel barges lying alongside. A 30-hp. single-cylinder marine engine is belted to a countershaft from which are driven the tumbler shaft of the ladder chain (by belt), the screen shaft (by gearing), and the sand conveyor shaft (by sprocket chain).

The ladder is 63 ft. long, and is made of two timbers 6x18 in., spaced 39½ in. apart, trussed laterally and vertically, and having cross struts about 6 ft. apart. It is pivoted around the main shaft (about 17 ft. above the deck) by means of boxing bolted to the timbers.

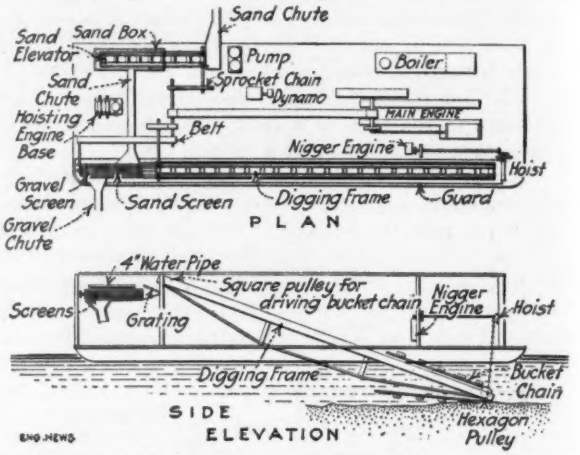


FIG. 2. PLAN AND ELEVATION OF SIDE-LADDER DREDGE

Keyed to the shaft is a square tumbler, each side of which is equal in length to that of one link of the bucket chain. The lower end of the ladder has a large hexagonal idler pulley, and to this end is attached a hoisting chain for raising and lowering the ladder. The chains wind on a large drum, operated by a small reversing engine through bevel gearings.

The ladder carries an endless bucket chain made up of link bars about 12 in. long, to which the digging buckets are bolted 5 ft. apart. Each bucket holds about 4 cu.ft. As the buckets pass over the tumbler on the main shaft, they dump the dredged material on an inclined grating, from which the larger stones roll back into the water, while the material passing through goes to two inclined cylindrical screens. The first or sand screen is of ¼-in. mesh and about 5 ft. long; following that is the gravel screen, of 2-in. mesh and about 4 ft. long.

The material entering the screen is washed by jets from a perforated 4-in. pipe, placed immediately over the screen, and these jets serve also to keep the meshes free. The finer material passing through the sand screen is led by a chute to a box on the other side of the hull. The material passing through the gravel screen is led by another chute into barges on the ladder side of the dredge. Any stones too large to pass through the screens go overboard. The sand-collecting box is about 4x12 ft.,

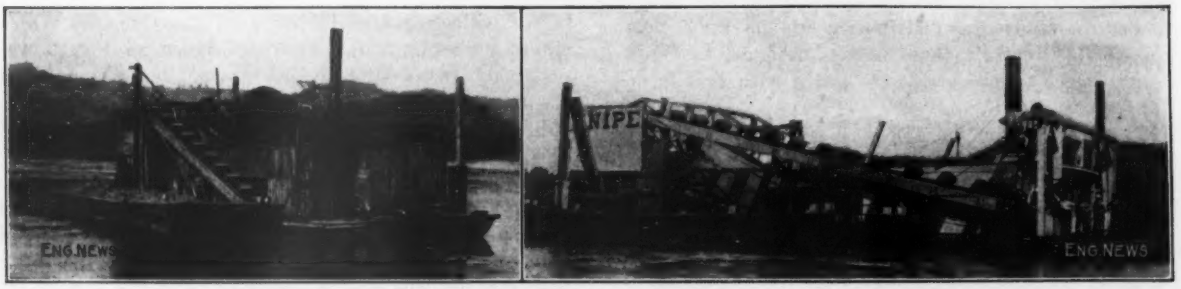


FIG. 1. SIDE-LADDER DREDGES FOR EXCAVATING SAND AND GRAVEL IN THE OHIO RIVER

(The dredge at the left, operated by the Missouri Valley Bridge & Iron Co., has a hull 24x100 ft., and a ladder frame 63 ft. long. The dredge at the right, operated by the T. A. Gillespie Co., has a hull 28x120 ft., and a ladder frame 75 ft. long.)

6 ft. deep, with a small weir on one side for the water to escape, carrying with it the dirt, clay or floating material. A bucket elevator takes the sand from this box and discharges it into a chute leading to barges.

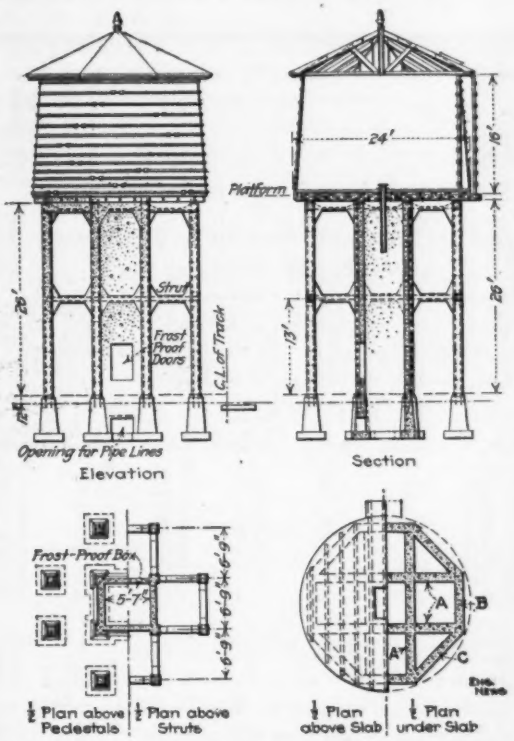


FIG. 1. STANDARD REINFORCED-CONCRETE TOWER OR SUBSTRUCTURE FOR 50,000-GAL. WATER TANK; ERIE R.R.

A two-drum hoisting engine, supplied with steam from the boiler, is used instead of the crabs and capstans usually employed for raising spuds and handling barges. The spuds are raised by cables running to the drums, while the barge lines are moved by the winch heads. The crew consists of engineman, fireman and two deck hands. In ordinary digging the machine will excavate about 50 yd. of sand and gravel per hour.

A larger dredge of the same type is shown at the right in Fig. 1, and is one of two used by the T. A. Gillespie Co., of Pittsburgh, Penn., on its contracts for lock and dam work on the Ohio River. The ladder is 75 ft. long, 4 ft. 6 in. wide over all and carries 28 buckets of 4½-cu.ft. capacity, made of ⅜-in. steel with reinforced lips. The ladder chain makes a complete revolution in about four minutes. The sand conveyor has 16 buckets of 3 cu.ft. capacity, and its chain makes a complete revolution in about 1¾ minutes.

This boat carries two marine boilers, one main engine (10½x36-in.), which operates both the ladder chain and the sand elevator, two capstan engines to operate the ladder hoists, and two double-spool steam capstans; also engines for operating the spuds or anchors, barges, lines, etc. The hull is 120x28 ft. and 5 ft. deep, with a draft of about 2 ft. when coaled and under steam. The weight of the ladder is counterbalanced by placing the boilers, sand bin and coal bunkers on the opposite side of the boat.

The dredge can operate successfully in water 30 ft. deep. Its capacity depends to a large extent upon the material to be handled, but for ordinary purposes it is estimated at 400 yd. per 8-hr. day. This boat was built by the Dravosburg Dock Co. and the machinery was manufactured and supplied by the Goodman Engine & Machine Co., of Pittsburgh, Penn. The total cost ready to operate was about $20,000 for each of the Gillespie Co.'s dredges.

Concrete Tower for Water Tank: Erie R.R.

The towers supporting railway water tanks are usually of timber or steel construction, but concrete has been used in a number of cases and the accompanying cuts show the standard design of the Erie R.R. for a reinforced-concrete tower for 50,000-gal. tanks, the tank itself being of wood. Fig. 1 shows the general design, while Fig. 2 shows some of the details.

There are four inner columns 8x8 in. and eight outer columns 14x14 in., with horizontal connecting struts at mid-height, except that these may be omitted when the height is less than 20 ft. The inner columns are built integrally with 8-in. curtain walls forming a frostproof air chamber around the pipes. At the top there are transverse beams and an octagonal ring girder 16 in. deep, supporting a 10-in. concrete slab 23 ft. diameter. On this are placed 6x6-in. timber sleepers to support the bottom of the tank. The slab is reinforced by 70-lb. rails, laid 2 ft. c. to c. All members have 1-in. chamfered edges.

Gravel concrete is used. The foundations are designed for a load of 30 tons per column, the foundations being carried to such depths as may be made necessary by the character of the soil. These structures are built under the direction of R. C. Falconer, Superintendent of Construction, Erie R.R.

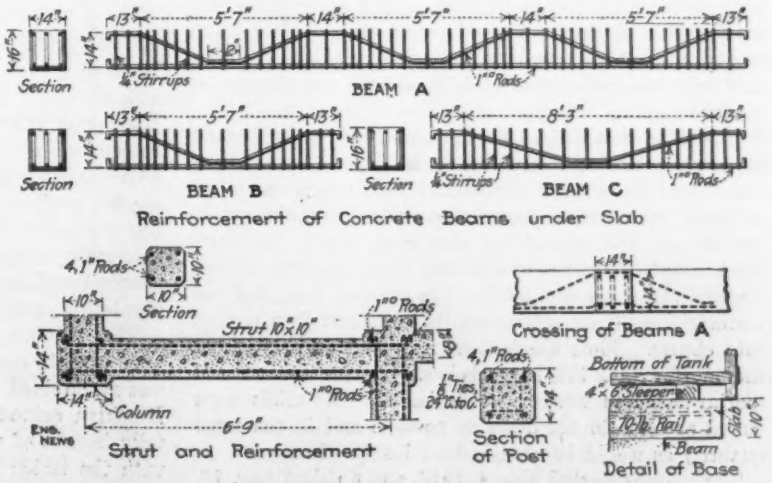


FIG. 2. DETAILS OF REINFORCED-CONCRETE TOWER FOR WATER TANK

Field and Office

Bricklaying Costs for 5 to 10-Ft. Brick Sewers at St. Louis, Mo.

By C. L. French*

An attempt to standardize bricklaying methods in sewer construction so as to secure the greatest efficiency at each step of the work was recently made in St. Louis. The contract on which this attempt was made was for the third section of the Glaise Creek Joint Sewer, which was carried out by the American Contracting Co. This contract consisted of 7370 ft. of brick sewer, varying from 5 to 10 ft. in diameter and from 13 to 18 in. in thickness. The total amount of brickwork was 10,264 cu.yd., consisting of 9600 cu.yd. common and 664 cu.yd. of vitrified brick masonry (to line the invert for the dry-weather flow).

It was found that by planning the work so that a certain number of bricklayers could be constantly employed, the best men could be kept. The importance of this feature is nearly always underestimated by contractors. The difference between the work done by a good man and an average man is at least 10%, and where full time can be made the very best men are obtainable.

The next step was to get the maximum of work from the bricklayers. This meant not harder work, but eliminating lost motion: The essentials were proper working room, sufficient materials in the right place, and safe working conditions. Solving each of these problems required much experiment. Too many or too few bricklayers in a given space was found to be equally expensive. Materials in the right quantity, just where needed, make it unnecessary for a $9-a-day bricklayer to wait for a $2.50 laborer.

The principle of "safety first" was found to be of more importance than merely a humanitarian measure. Accidents demoralize efficient work, and a little extra care and expense along this line will more than pay for itself. For example, brick baskets were used instead of slings, and only material immediately to be used was allowed on scaffolding.

The elimination of useless labor was one of the greatest problems. Mortar was mixed by machinery at a cost of less than 1c. per cu.yd. for power. Great care was taken to have this mortar of just the proper consistency. It was found that, everything else being equal, the day's work could be increased 2 or 3% by *having the mortar exactly right all the time.* The mortar was dumped directly from the machine into barrows and then poured into chutes. Thus the bottom man had only to direct the mortar into the boxes below. Mortar mixers and mortar lowerers were thus eliminated. Materials were stored as close to the ditch as possible and in the same quantity as would be used in that length of sewer.

The job was started Nov. 4, 1913, and finished Aug. 18, 1914.

The cost data are based on the following prices for labor and material delivered:

Bricklayer	$1.12½	per hr.
Labor	0.31	per hr.
Brick, common	8.50	per M
Brick, vitrified	16.50	per M
Cement	1.40	per bbl.
Sand	0.85	per cu.yd.
Electricity	0.10	per kw.hr.

The constants for each cubic yard of brick were:

430 common brick at	$8.50	$3.66
338 vitrified brick at	16.50	5.58
0.65 bbl. cement at	1.40	0.91
0.35 cu.yd. mortar at	0.85	0.30
0.10 kw.hr. at	0.10	0.01

The mortar was 1 part cement to 3 parts sand.

This makes the material cost $4.88 per cu.yd. for common and $6.80 per cu.yd. for vitrified-brick masonry.

The monthly records were as follows:

	Cubic yards laid			Cost per cu.yd.		
Month	Common	Vitrified	Per day of 8 hr. per bricklayer	Labor	Total, common	Total, vitrified
Nov., 1913	768	53	9.3	$2.25	$7.13	$9.05
Dec., 1913	1444	99	10.8	2.02	6.90	8.82
Jan., 1914	1260	87	11.7	1.90	6.78	8.70
Feb., 1914	60	4	12.0	3.00	7.88	9.80
Mar., 1914	416	29	10.5	1.90	6.78	8.70
Apr., 1914	1132	78	11.8	1.78	6.66	8.58
May, 1914	970	68	11.0	2.24	7.12	9.04
June, 1914	1019	70	9.9	2.26	7.14	9.06
July, 1914	1912	133	12.6	1.77	6.65	8.57
Aug., 1914	619	43	8.5	2.65	7.53	9.45
	9600	664				

Average cu.yd. per bricklayer per day of 8 hr.		$11.05
Average labor cost per cu.yd.		2.02
Average cost of brickwork per cu.yd.	common	6.90
	vitrified	8.82

The high cost of labor in May is due to tunnel work at night, when double time was paid to bricklayers. The high cost for June is due to bad working conditions, where frequent cave-ins caused much delay. The last month's figures are not significant, as the best men had left for other jobs and lots of cleaning up was necessary.

*Assistant Engineer to Sewer Commissioner, 2925 North Newstead Ave., St. Louis, Mo.

Adjustable Orifices for Measuring the Flow of Sewage

By John H. Gregory*

The control and measurement of the flow of small volumes of sewage is somewhat troublesome and the writer was especially interested to read the article by Geo. T. Hammond (Oct. 22, 1914, p. 836), on the use of calibrated orifices for the purpose at the Brooklyn Sewage Experiment Station. The writer was confronted with a similar problem in 1904 when designing the sewage-testing station at Columbus, Ohio,† and after careful consideration, adopted adjustable brass orifices as being the simplest and most practicable device for measuring and regulating small volumes of flow.

The Columbus orifices, as are the Brooklyn orifices, were used in connection with a box in which the sewage was maintained at a constant level but differed from the Brooklyn orifices in that they were adjustable horizontally instead of vertically and were set inside of the box, with the inside face of the orifice flush with the inside of the box, instead of outside of the box as at Brooklyn. Also, they were so constructed that all four edges of the orifice were in the same plane.

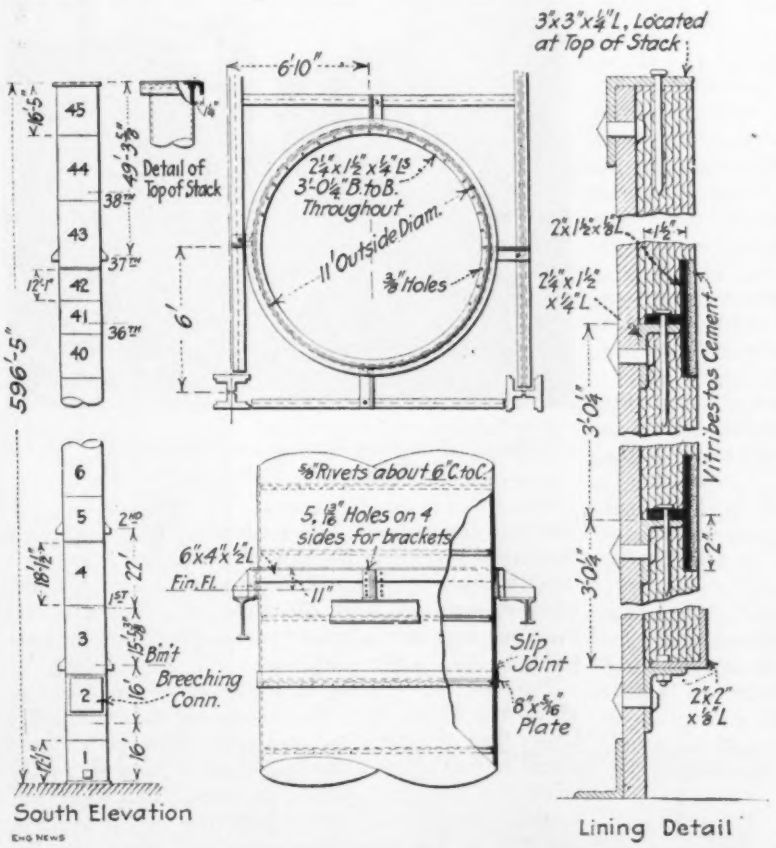
*Consulting Engineer, 170 Broadway, New York City.
†"Engineering News," Vol. 52, Oct. 20, 1904.

The orifice was adjusted by means of a handwheel carried on the end of a stem which projected out through a threaded nut set in the side of the box. The opening of the orifice and corresponding flow was obtained by determining, by means of a scale, the position of the wheel with reference to the nut.

The principle involved in the Columbus and Brooklyn orifices is the same, the differences between them being in the details of construction and setting. These differences are only of minor importance, as orifices of this kind should be calibrated if the most accurate results are desired.

Largest Interior Steel Stack, Equitable Building

The largest stack included in the construction of any office building to date, is the lined-steel stack of the new Equitable Building, New York City. It is 11 ft. in diameter by 596 ft. 5 in. high, plates $\frac{5}{16}$ in. thick. The stack is supported on the steelwork of the building at every other story. Just below each point of support is a slip-joint to allow for expansion. The general design of the stack, the method of anchoring to the building steel, design of the supporting bracket, type of slip-joint, the method of holding the stack lining in place, and other features of the construction are shown in the accompanying drawing.



General Design of Equitable Stack

Erection of the Stack—The steel sections, which vary in height from 12 to 18 ft. ½ in., were trucked from lighters on West St. to the front of the site on Broadway. As a problem in transportation, it is interesting to note that only one street was found which gave sufficient clearance throughout its length to permit the sections being carried directly to the site, without being unloaded and rolled under elevated railway structures. The city requires that all structures over streets shall have a height of at least 13 ft. above the pavement. In this particular instance, the loaded truck required a clearance of 16 ft.; a depression on Morris St., under the elevated-railway structure gave a clearance of 16 ft. 4 in., and here the load could get through under the structures on Greenwich St. and Church St.

At the site, a section was lifted from the truck, on Broadway, by a derrick, and deposited on the steelwork above. A second derrick picked up the section and swung it into the stack shaft. An ordinary derrick gang was able to handle a section.

The stack rises from a concrete base at the sub-sub-basement level. Its rate of erection was dependent upon that of the steelwork of the building.

Lining Stack—The lining of this stack differs from that of most interior stacks in that it extends the entire length.

The lining used (J-M Vitribestos) is formed of alternate layers of plain and corrugated asbestos board coated with a supposedly vitrified compound. It comes in curved slabs about 40x35 in. in plan by 2 in. thick. The slabs are sawed to fit between angle irons which encircle the inside of the stack 3 ft. apart, and they are held against the stack by angle clips fastened to the circular angles by nails, and the joints closed with Vitribestos cement, as shown in the vertical section sketch.

Application of the lining was not commenced until the stack steel had risen 26 stories. A piece was then cut from the section at the 12th floor, large enough to permit the entrance of workmen and material. After all the slabs were placed from the 12th to the bottom, the joints were cemented. An opening was then made in the stack at the 24th floor and the above process repeated. Later the cut pieces of steel plate were welded back in place.

The lining was applied by two men on a scaffold suspended in the stack. A third man prepared the cement and lowered it and the slabs, etc., down to the workmen. The work advanced at the rate of about 20 ft. per day, which was considered very satisfactory progress.

Personnel—The steelwork of the stack was furnished by the Dover Boiler Works, and erected and lining applied by the Thompson-Starrett Co. (George Simpson, Chief Engineer; H. S. Gardner, Superintendent of Construction), New York City, general contractor for the building. The lining was furnished by the H. W. Johns-Manville Co.

Notes on the Computation of Boundary Surveys

By A. W. Bedell*

Computations for boundary surveys should be put on quadrille ruled paper; that is the results, the logarithmic work not being saved.

In finding the latitude and departure of a course the work is simplified by writing the *log distance* in the center with the *log sin* and *log cos* above and below it, additions being made at both top and bottom. When the latitude and departure of a course are given and the bearing and distance are required, the *log tan* of the bearing is found by subtracting the *log latitude* from the *log departure.*

Then either the *log sin* or *log cos* of the bearing is looked up (whichever is greater; the larger function is always in the right-hand column), and subtracted from the *log latitude* or *log departure* (whichever is greater) which gives the *log distance.* The reason for doing this is that the percentage of error of the smaller function, taken together with the shorter side, is relatively so great as to make it less reliable in determining the length of the hypotenuse.

Smoley's five-place *log* tables are nearly as accurate as Vega's for single minutes only, and much quicker. Boileau's traverse tables are very quick for finding latitudes and departures, but cannot be used for the reverse operation. If very much of this kind of computation is done, the most efficient way is with five-place tables of natural functions and a computing machine, which will save about 50% of the time. All computations should be checked either directly or by the reverse operation.

With angles read in the field to minutes, and distances to 0.01 or 0.05, the final courses should not be computed any closer than those measured; to do so only gives a deceptive implication of greater accuracy.

It will often improve the closure to first distribute the angular error before commencing computations. The error in latitude and departure is distributed only on the longest courses.

The D. M. D.'s and latitudes need not be closer than tenths in multiplying for areas, which in turn need only be recorded to single square feet. Results will then be reliable to 0.001 acre.

It is quicker to multiply for areas than to interpolate with logarithms. Areas can be checked graphically by subdividing the plot into triangles and scaling the bases and altitudes, with results generally accurate to 1 in 500.

When the area is known in square feet, a rough check on the acreage may be found by pointing off six places and multiplying by 23, which is nearly the reciprocal of 43,560.

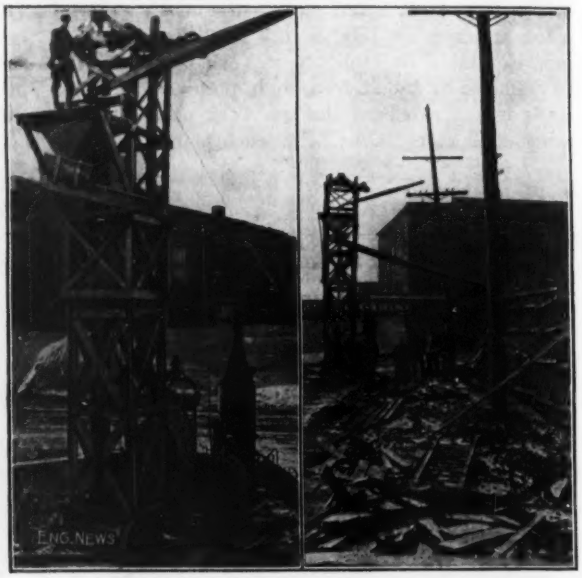
*Chappaqua, N. Y.

Portable Concreting Plant with Telescopic Tower

In building the concrete bridges over the railway tracks in the grade-crossing elimination work at Tower Grove, St. Louis, Mo., two different methods were employed for placing the concrete. For the portion over the St. Louis & San Francisco Ry. (done by contract), a portable plant with mixer and short telescopic elevator tower was employed, while for the portion over the Missouri Pacific Ry. (done by company force) the plant was stationary and had the usual tall tower and long chutes.

The portable plant, shown in the accompanying cut, was very inexpensive, and was readily moved from place to place as the work progressed. It consisted of a ⅓-yd. mixer with a small steam engine and boiler, mounted on a self-propelling four-wheel frame or truck. The elevator tower was mounted on a pair of sills, having the end supported by and bolted to the mixer frame, while the rear end was carried by a pair of wheels.

The usual cable for hoisting the charging skip of the mixer was disconnected from the drum, and a right-angled hook was spliced upon its end. A hole was bored in the face of the drum to engage this hook. A similar



Portable Concrete-Mixing and Delivering Plant with Telescopic Elevator Tower

hook was attached to the bucket-hoisting cable. This arrangement permitted the use of the same drum for hoisting the charging skip and the concrete bucket, the one being removed while the other was in operation. This was done by a man stationed at the drum for this purpose.

The tower was 4½x4½ ft. in plan in the lower section, which was 22 ft. high. The upper section was slightly larger than the lower half and could telescope over the latter, so that a minimum height of 22 ft. could be obtained, for passing under electric wires. This upper section was 18 ft. high, and the maximum height of tower was 34 ft. The tower was raised and lowered by the hoisting cable and a set of blocks.

A tilting elevator bucket was used, and at the top of its travel it discharged the concrete into a hopper attached to the tower. From the bottom of this hopper extended a chute 25 ft. long, which was suspended by stays from a boom at the head of the tower.

This portable concreting plant with telescopic tower was designed jointly by Perry Topping, Assistant Engineer, St. Louis & San Francisco Ry. (who is in charge of the grade-crossing elimination work at Tower Grove),

and G. D. Weeks, Superintendent for the Jarrett-Richardson Co., which has the contract for this work.

When the nature of the work in progress does not require the tower, it is uncoupled, the charging skip is rigged to the drum and the mixer is then available for concreting the street foundations, sidewalks, etc.

The capacity of this plant was about ⅓ cu.yd. of concrete at a batch and 1½ minutes was required for each batch. The highest record of work done by the plant was 90 cu.yd. in 10 hr. This plant was very satisfactory for the work, which consisted of retaining walls with a maximum height of 14 ft., having expansion joints 35 ft. apart, the wall being built in alternate sections. These walls were situated on three different streets, along which ran numerous electric wires and on two of which ran street cars. The tower was moved twice in the length of the walls, and the work was done without interrupting the street traffic.

Fire-Pail with Foil Cover—An improved metal fire-pail covered with foil to prevent evaporation and the accumulation of rubbish, is made by the Eureka Chemical Fire-Pail Co., Philadelphia, Penn. The pail is refillable. The foil, which is easily broken by the hand, is protected by a metal lid normally. The pail is enameled.

A Sectional Telescoping Hoist-Tower

A sectional telescoping hoist-tower is a novelty brought out by the Lorentz Iron & Machine Works, 95 Liberty St., New York. The two views herewith show such a tower in position, set up and when telescoped and loaded on a wagon. The tower is built in 15-ft. sections, telescoping successively, framed of steel angles. The lowest section is provided with winding shafts, worm-geared, by means of which the several sections are raised to extended position. Important features of advantage are the speed of setting up and taking down the tower, and the absence of damage or deterioration in taking down and reërecting.

TELESCOPIC CONCRETING TOWER

Testing a Testing Machine; Simple Method

BY JULIAN C. SMALLWOOD*

For calibrating vertical testing machines of the Olsen or Riehlé type, the makers recommend the use of "proving levers" such as are illustrated by Fig. 1. Arranged as shown, the force produced by weights suspended from

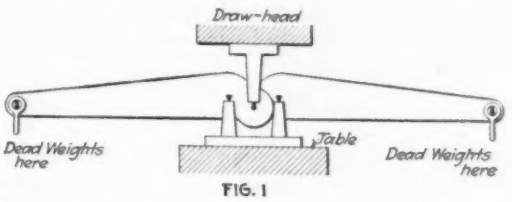


FIG. 1

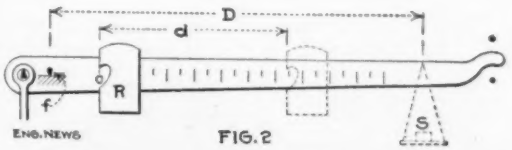


FIG. 2

FIG. 1. PROVING LEVERS ON A TESTING MACHINE

FIG. 2. WEIGHING BEAM WITH AUXILIARY SCALE PAN IN PLACE

the ends of these levers will be multiplied by the ratio of lever arms, 10, and transmitted to the table of the testing machine. The multiplied force may then be measured on the testing-machine beam, and the machine calibrated. It is customary to test the machine in this manner up to one-tenth its capacity. It should be noted that the calibration, being static, does not duplicate the actual conditions of use, namely, the balancing and measuring of moving forces.

It was sought by the writer to prove a 200,000-lb. machine used in the laboratory of Syracuse University. The method outlined above was objected to because it involved the handling of 2000 lb. of dead weights. Consequently another method was devised, the theory of which is as follows:

THE NEW METHOD

The weighing beam of the machine, Fig. 2, is fulcrumed at f and carries the rider R which may be adjusted at a distance from the fulcrum such as fo balance any load applied to the testing-machine table. With no load, the rider is in the position shown, its pointer being at the zero graduation and its beam floating. With a load W on the table, the rider must be moved through a distance d to secure balance. If the machine is correct, the weight of the rider must be such that the distance d will be that between the zero and the graduation marked W. Now, instead of using the rider, another weight could be applied at any convenient part of the beam as shown by S, of such amount as to secure a balance when the load W is on the table. Therefore, the moment of the weight

*Associate Professor, Experimental Engineering, Syracuse University.

S about the fulcrum f must equal the moment of the rider which is replaced. Letting R denote the weight of the rider,

$$S \times D = R \times d$$

Let the ratio of the load on the table to the balancing weight S be L. Then

$$S = \frac{W}{L}$$

Substituting this in the first equation, and simplifying, we find the weight which the rider must have in order to suit the existing graduation of the beam:

$$R = \frac{D}{d} \times \frac{W}{L}$$

To apply this relation to the calibration, a value of W is chosen, and the distance between the beam graduation marked W and the zero graduation is carefully measured. This determines W and d. A point is then chosen to represent D, and its distance measured from the fulcrum f. To find the ratio L, it is not necessary to apply the full weight W to the table, since the ratio $W:S$ is constant for all values of W, the ratio of levers being established by the selection of D. Therefore the following procedure is used. An appreciable, but not inconvenient, number of weights is placed on the table, these having been previously measured with a platform scales to within 1 lb. They may consist of anything available that may be readily moved. A balance pan, improvised from pasteboard and wire, is then attached to the beam at the distance D from the fulcrum, and to this pan are added shot or other small weights until a balance is secured. If desired, the weight of the pan may be previously balanced by the usual beam counterweight so that the experimenter need deal with the added weight only. The latter should then be accurately weighed to a fraction of an ounce. This result, divided into the weight applied to the table, gives the desired ratio L. The value thus obtained completes the data necessary to calculate the weight of the rider according to the equation previously deduced. The rider is then removed from the beam and weighed; if the actual checks the calculated weight, the machine is proved at the graduation marked W. Any other graduation may then be checked by proportion, since the distances of the graduations from the zero mark must vary directly with the indicated loads.

Test of a 100-Ton Machine

Following are the data and results from the test of the previously mentioned 200,000-lb. machine.

Beam carried two tandem riders to balance successively 100,000 lb. each; W was chosen at 100,000 lb. so as to make the error in measuring d as small a percentage as possible; $d = 40$ in.; $D = 49.69$ in. To find L, a dead weight was placed on the table equal to 825 lb. Balancing weight, acting with arm D, rider being at zero, was 0.199 lb. Hence

$$L = 825 \div 0.199 = 4145$$

Then the rider should weigh

$$R = \frac{100{,}000}{4145} \times \frac{49.69}{40} = 30 \text{ lb.}$$

The actual weights of the riders were found to be 30.3 lb. and 30.4 lb. The lever system of the machine was thus proved to about 1% of error.

When determining L, it is well to make several trials involving different loads on the table, for checks. It is also important that the error brought about by lack of sensitiveness of the beam be estimated. This may be done after a balance has been secured, by noting what weight of shot may be added to or subtracted from the improvised pan to appreciably disturb the balance. The proportion that this bears to the whole weight of shot gives the proportion of error in the determination of L, since the load on the table is found with comparative exactness.

Sources of Error in Testing Machine

It is believed that this method of calibration is quite as reliable as the proving levers, besides having the merit of convenience; but, on the other hand, it seems that any static calibration should be supplemented by further examination. The question arises, at what points in a geared testing machine may sources of inaccuracy be looked for. One would not expect ordinary service to alter the arrangement of the levers, and, if this is the case, the beam would be expected to retain its accuracy, if the riders are not tampered with. Abuse of the machine might conceivably set the links connecting the levers or the knife-edges awry, which might make the balance sluggish without materially affecting the lever ratio. Grit from stone or concrete samples, if allowed to collect around the knife-edges, would have this result, as would the rounding or flattening of the knife-edges. In regular operation, sluggishness of the lever system would result in the rider being always behind its true position.

The rider is commonly advanced along the beam by means of a screw actuated by a handwheel set in the frame. The reaction on the beam caused by the force transmitted through the screw causes a slight lifting effort on the beam. If the rider does not work freely on its screw, this lifting effort may be considerably increased so that, in operation, the rider will be materially in advance of its true position in order to balance the lifting effort.

From these considerations it will be seen that the static calibration of a testing machine should be supplemented by an examination of all its knife-edges, and that the handwheel controlling the rider should be tried for its frictional resistance. Further, it should be ascertained that the table is free from the power screws, and from the guide bolts passing through it. Finally, a test for sensitiveness may be made as follows:

Test for Sensitiveness

A large, rigid metal piece of any convenient shape is placed on the table as for regular compression test. A moderate load is applied, say 20,000 to 30,000 lb., the beam balanced by *advancing* the rider, and the reading recorded. The rider is now further advanced by a few inches, then *returned* until the beam again balances, and a second reading taken. If this is less than the first, the difference may be due to the reversal of frictional resistance of the screw, the lifting effort being changed to a depressing one. If greater, it may be due to sluggishness of the lever system. If the two readings depart more than 1 or 2% from their average, the cause of the error should be sought. This experiment should be repeated at several loads, care being taken not to exceed the elastic limit of the material under compression.

Unit Steel Forms for Concrete Floors and Walls

The accompanying view, Fig. 2, shows the wall forms used by Collins Bros., contractors, in the construction of the reinforced-concrete building for Henry Dart's Sons Co., at Rock Island, Ill. These forms, which are used in the building for both wall and floor-slabs, are of special unit type devised by the Blaw Steel Construction Co., Pittsburgh, Penn. The diagram in Fig. 1 shows the sheeting in detail.

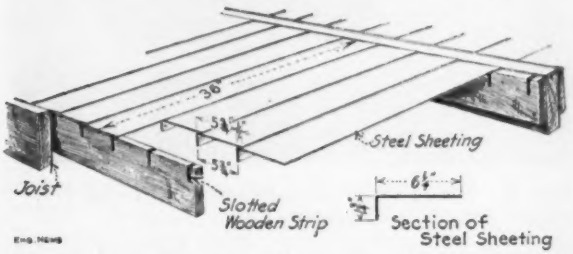


FIG. 1. DETAILS OF BLAW STEEL SHEETING FOR CONCRETE WALL AND SLAB FORMS

Each unit consists of an L-shaped section of light pressed steel, 36 in. long and 6¼ in. on the long side and 1¾ in. on the short side of the L. This 36-in. length spans the joists of the falsework in a floor or the studding in a wall form, the short leg of the L fitting into saw kerfs spaced 5¾ in. apart on light studding nailed to the main joist, as shown in the upper part of Fig. 1. This spacing allows a ½-in. overlap of the long leg of each unit on the next unit and the continuous line thus presents a tight surface for the concrete of slab or wall, broken only by the evenly spaced ridges at the overlap.

FIG. 2. WALL OF DART BUILDING, ROCK ISLAND, ILL., SHOWING UNIT FORMS IN PLACE

At the end of a few days, when the concrete has taken an initial set, the supporting studding may be taken down and the sheathing made ready for use again; meanwhile the slab or wall is supported at 36-in. intervals by the joist or stud which is left in place for the three or four weeks required before the entire removal of forms.

A Light Portable Wagon Loader

The use of mechanical wagon loaders in place of hand shoveling, for placing gravel, stone, sand, coal, ashes, etc., on wagons or motor trucks, is becoming very general, on account of the large saving in cost over hand shoveling. In the machine of this sort here illustrated, the effort of the designer has been to cut down the weight to facilitate the easy removal of the machine from one place to another. As seen in the illustration, a light steel pipe frame is used, and the weight of the entire machine has been cut down to a thousand pounds. Ball bearings have been introduced into the principal working parts, thus reducing the friction so that a little gasoline engine of only 1 hp. is sufficient to drive it; thus, the power equipment adds but little weight to the loader.

A LIGHT PORTABLE WAGON LOADER

In order to further facilitate the movement of the machine, its weight is balanced about the main pair of wheels, so that by pressing down on the projecting handles one man can balance it on these wheels and readily turn it. After the machine is set in place, ready for work, the handles can be pushed back out of the way. This machine, which is called the Jersey Wagon Loader, is manufactured by the Lorentz Iron & Machine Works, of Jersey City, N. J.

A New Dipper Handle for Dredges and steam shovels is composed of two steel channels placed with their flanges inward and welded together, so that they form a single member of rectangular box section. The design is patented and is being introduced by the American Steel Dredge Co., of Fort Wayne, Ind.

NOTES

A Good Record for an Old Dredge is reported in the "Canal Record" of Sept. 16. The French ladder dredge "Badger," which was built in Belgium in 1886, has just been condemned on account of defects in its hull. The dredge was operated at Panama by the French company organized after the De Lesseps collapse and was beached when the work was suspended. It lay unused and uncared for until 1908, when it was repaired and put in service, about $58,000 being expended in the work. Since that time it has been operated almost continuously. The fact that the iron hull and the machinery of this vessel have withstood the tropical climate of the isthmus for twenty-eight years is noteworthy. The dredge had buckets of 15 cu.ft. capacity and was capable of excavating to a depth of 45 ft.

Plaster-Board Forms and Ceiling for Ribbed Concrete Floors—A new type of ribbed-floor construction in reinforced-concrete employs inverted troughs of gypsum plaster-board as permanent forms for the ribs and slab, with flat plates of the same material for the ceiling. This material (Sackett plaster-board) is pressed to shape for the troughs, and before setting these in place the ceiling plates are attached to the flanges by means of metal clips. The construction is shown in Fig. 1, and Fig. 2 shows the troughs nested for transportation.

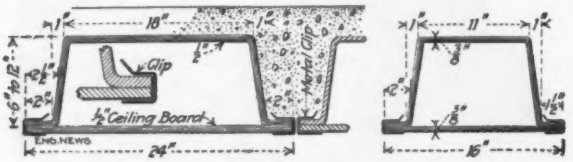


FIG. 1. RIBBED CONCRETE FLOOR CONSTRUCTION, USING FORMS AND CEILINGS OF GYPSUM PLASTER-BOARD

The troughs are made of different sections, in 36-in. lengths, and can be sawed to any required length. Their ends are closed by flat plates. The plaster board is treated with a waterproofing composition, so that it will not be liable to injury by the weather during transportation or on the work. The material adds very little to the weight of the floor, the weight being only about 7½ lb. per sq.ft. for troughs 24 in. wide and 10 in. deep, with ceiling board in place.

The plastering for the ceiling is stated to cost 20 to 40c. less with this construction than with steel lath. The plaster-board also is rigid and will not sag or bulge. The extra fine protection of the surface of the concrete ribs by ⅛ to 1 in. of plaster-board is claimed as a further advantage.

This system of floor construction has been adopted for the Y. M. C. A. Building now under construction at Streator, Ill. This is a three-story building of reinforced concrete about 50x86 ft., with spans of 13, 18 and 24 ft. The loads

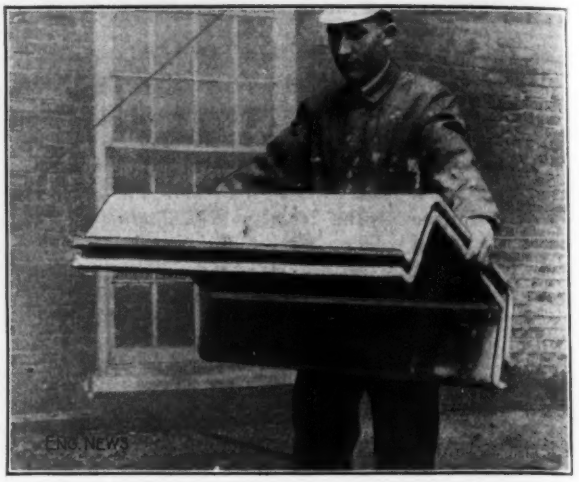
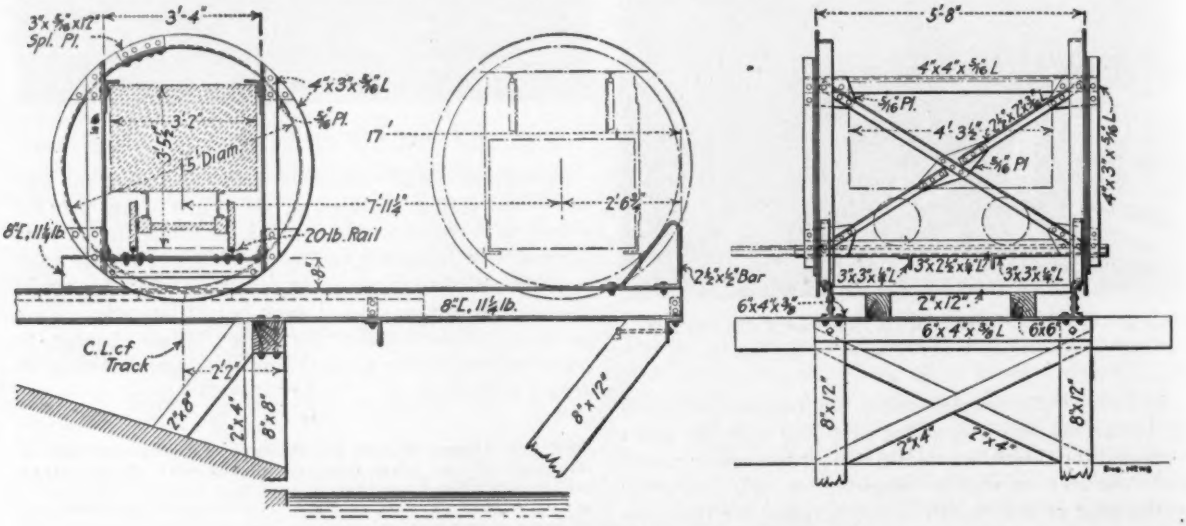


FIG. 2. FORMS OF PLASTER-BOARD FOR RIBBED CONCRETE FLOORS

are 150 lb. per sq.ft. for the first floor and 60 lb. for the upper floors. The troughs are 24 ft. wide over the flanges, with a depth of 6, 8 and 10 in. for the three lengths of span noted. The material is supplied by the United States Gypsum Co., of Chicago. The contractor is H. Tappendorf, of Streator. The architects for the building are Foster & McLane, of Streator.

An Improvised Car Dumper, designed by S. E. Roof, Assistant Engineer, Cleveland Water Department, and built under his direction, has been in use on the water-works intake at Cleveland in the disposal of the excavation from the tunnel and of the débris from cleaning out of an old tunnel which leads into one of the cribs. In the accompanying figure details of the dumping device are shown. On the crib into which the tunnel leads there is erected a cantilever frame carrying two 8-in. channels out over the lake. On these channels as rails a cylindrical steel framework rolls from a fixed bumper, made of 8-in. channels riveted to the top of the rail channels above the crib, to an outside bumper made of 2½x½-in. bars bent up at the extreme end of the cantilever frame. When at its inside position the cylinder frame carries at its bottom section a narrow-gage track, which is continuous with a track leading out from the elevator in the crib. A small narrow-gage dump car is filled from the elevator and run out over the track into the cylinder frame. The frame is then given a push by laborers and rolled out on a slight down grade of the cantilever, the car meanwhile overturning and being held from falling out by bracket angles riveted to uprights, shown in the cut. When the car-load is thus dumped overboard, the empty car in the frame is pulled back into its place.



CAR DUMPER USED ON WATER-WORKS CRIB, CLEVELAND

Editorials

The Market for Municipal Bonds

In the three months since the declaration of war in Europe, from Aug. 1 to Oct. 31, the sales of municipal bonds in the United States fell off about $50,000,000, according to statistics collected by the *Bond Buyer*. The total sales of municipal bonds during these three months were $31,311,000, whereas in the same three months in 1913, $79,790,000 was marketed. In the three months preceding the outbreak of the war over $100,000,000 of such securities were sold.

There are signs, however, indicating that the coming month may see a revival in the demand for municipal bonds. A large proportion of the sales of such bonds are to savings banks and life-insurance companies, and there is little doubt that during the closure of the stock and bond markets since the war began, money has been accumulating to a considerable extent which is available for investment. There has been, in fact, a very marked improvement in the general tone of the Wall Street money market.

Two influences which have withheld investors from purchasing have been the feeling that with the opening of the financial markets again it would be possible to obtain exceptional bargains in investments, and the feeling that with the uncertainties of the world situation, it was a safe plan to keep a considerable supply of money available for instant use. Both these conditions are passing, and as soon as the bond market is fairly in operation, a considerable increase in the sales of municipal bonds may reasonably be expected. If this prediction is realized, it will be most gratifying to the cities who are holding back important public works until they can secure capital, and to engineers and contractors whose employment depends upon such financing.

Commission Government for Buffalo

The City of Buffalo at the election last week voted to adopt the commission form of government, and will be the largest city in the United States to try this plan of administering its municipal affairs. As our readers will recall, ENGINEERING NEWS has at no time maintained that the commission plan was an ideally perfect form of municipal government; and as most intelligent men realize, no plan of government for a city, or a state or nation can be successful, save as it is administered by men of ability and honesty.

It remains true, nevertheless, as every engineer, at least, will agree, that the old plan of city government with its multiplication of officers is cumbrous and inefficient compared with the commission plan and its concentrated responsibility.

That old plan of city government, which is still in use in many cities, where the mayor is the executive head with two different legislative bodies to act as a check upon each other, was intended to be a copy of the scheme of government in use in the several states. One main defect of a government of this sort is that it is far better adapted to prevent things being done than it is to do things. A century ago, when the old aphorism that that government was best which governs least was widely accepted, the attainment of efficiency in a municipal or a state government was not necessarily a matter of vital importance.

The governments of the present day, however, are doing many things which were undreamed of a century ago and the tendency all the time is to increase the work undertaken directly by the municipal government. Under these conditions it makes a vital difference to the taxpayer and the citizen whether efficiency or inefficiency prevails in the government of his city. The mere fact that the commission form of government is more efficient by far than the old mayor, aldermen and council plan makes the change in Buffalo one upon which its citizens are to be congratulated.

One-Sided Engineering Contracts

Something is radically wrong with either engineers or lawyers when a lawyer* is led to write as follows:

> The entire trouble is with the present-day construction contracts and their specifications or at least the general conditions of the specifications. In discussing the present-day railroad construction, the following has been stated: "It is safe to say that in no other business relations between men are such one-sided agreements customary; in no other relation is a man conceived to be clothed, by reason of an instrument, in a mantle of infallibility, as is the engineer in customary railroad contracts." The same is true of all United States, state and all municipal contracts, and even of many private contracts. From personal knowledge of contracts of the City of New York and the interpretations by the Corporation Counsel and some of the engineers, I am of the opinion that in signing such a contract the contractor, architect, or engineer gambles worse than on the stock market. He frequently becomes an insurer and an exponent of faith, hope and charity.

A contract is supposed to be a fair bargain. In all the decisions and discussions of engineers, fairness is always assumed to be the keynote of the relations between the engineer and contractor; but by the above quotation and by very general experience as well, many (if not most) contracts are so far from fair that it would be undeserved praise to even call them unfair.

A mere ethical protest against such a condition might be commendable; but it would have little chance of success. If engineers can write such contracts and enforce them, they will doubtless continue to do so, notwithstanding all ethical protests. But when courts of law decline to recognize such contracts, and insist on interpreting them in the courts' own way, on a basis of fairness, regardless of the specific terms of the contract, then engineers are bound to stop and give the matter thought.

*Wm. L. Bowman, in a recent address before the Harvard Society of New York, "The Engineer and the Law."

How long will engineers continue to write contracts and specifications that are not only grossly unfair, but are without legal force?

The Yale Bowl

The novelty of the structure erected at Yale as a football amphitheater lies not only in its popular aspects, but just as much in its construction and design. Gathering 61,000 people in a walled camp, which can be entered and left only through tunnels, is rather radically new. There is every reason to believe that the innovation will be fully justified by the success of its first trial—at the Harvard-Yale football game on Nov. 21.

To build a concrete grandstand on a freshly placed earth embankment is almost as novel as the general idea of digging out an amphitheater below ground-level in order to furnish material for the embankment—an operation which called for the adoption of very special methods of excavation in order to handle the job cheaply and expeditiously. Of course, the problem was to secure a dense and firm embankment on which the seats could be built without settlement; and there was some difference of opinion, we understand, as to how this problem ought to be handled.

The original project contemplated making the embankment a simple dump, without much or any attempt at consolidation: the material was to be deposited in 18-in. layers and not rolled. The contract and specifications were actually drawn on this basis. Later, when the contract had progressed some distance, after the tunnels through the bank and the first few feet of bank had actually been constructed, the engineers in charge modified their views, and came to believe that the embankment should be made fairly firm and solid from the start. The contract was thereupon altered to call for what amounts to reservoir-embankment construction, depositing the material in thin layers and rolling it thoroughly.

Of some interest in the same connection is the fact that it was originally planned to build the concrete seating structure all the way up the slope, on the fill as well as on the part in cut, and this with unconsolidated fill as originally contracted for. The later decision to put a temporary wooden seat-bank on the embankment, and restrict the concrete seating for the present to the portion which is in cut, will certainly be regarded as wise.

This notable structure, unfortunately, will be very seldom used. We understand it is to be used for the college football games only. It seems that only in the fall, and then for not more than possibly half a dozen afternoons, will it be in service. The field is too small for baseball, and the whole structure is regarded as unsuitable for track and field sports, for which another stand on another field will be provided. On account of its large seating capacity, the bowl ought to pay well; nevertheless its efficiency must be regarded as low, under the circumstances.

Original Cost vs. Replacement in Railway Valuation

In commenting in these columns upon the Federal Railway Valuation Act at the time it was passed, we criticized the clause in the act which requires the valuing engineers to determine not merely the cost of replacing the line at the present time, but also what was the original cost of construction, together with the amount which have been expended since on improvements. We suggested that this clause in the law would require a search into past history, requiring a vast amount of labor, and that many of the facts necessary to complete the records could never be unearthed.

An interesting illustration of how this task of searching past history works out in practice is furnished by a circular issued by the Valuation Committee of the Central Railroad of New Jersey, of which Charles Hansel is the Chairman. The circular states that representatives of the railway company who will accompany the Federal Valuation Engineers, will point out to them certain obscure items which materially increase the cost of the completed work, and which are not apparent in a field inspection. Mr. Hansel makes the following list of some of the items which may have caused a large increase in the cost of original construction, and yet be not at all apparent now.

> Sunken embankments, old excavations filled up, trestles and other structures which have been filled with earth embankment, sink holes, cuts which were wet during construction and therefore caused extraordinary costs, but which are now dried out; disintegrated or earth-covered rock cuts, which might now be classified as earth at a low price when compared to the original cost of rock excavation; temporary roads, trestles, tracks, embankments, dams and other structures required during construction, traces of which have disappeared; excessively costly foundations of bridges, buildings and other structures; unsuspected drains and culverts; conduits, sewers, catchbasins, water pipes, dikes, dams, cribbing, retaining walls, flumes, ditches, rip-rap, mattresses, etc., not readily discovered, and especially those which are outside of the right-of-way; roads, channels and streams which have been diverted, but knowledge of which cannot be had from mere inspection; materials which were originally ballast, but which have settled below the subgrade; items incident to eliminating grade crossings, elevating, depressing or changing tracks, particularly under traffic, and similar extraordinary construction costs; penalties paid contractors for delay in furnishing material or facilities; extra cost of work owing to extraordinary weather and labor conditions, strikes, etc., or on account of suspension and later resumption of the construction; curbing, paving, drainage, etc., of streets, and later resumption of the construction; curbing, paving, drainage, etc., of streets, and other improvements of various kinds off the right-of-way, paid for wholly or in part by the railroad companies; special assessments levied against the railroad companies for general public improvements, etc.

Mr. Hansel declares that in many cases the only way to determine the facts in the relation to many of the items above cited will be through the personal recollection of those who were connected with the original construction work. He is therefore sending this circular to every present employee of the company and to all former employees, so far as they can be located, especially in the engineering department. He appeals in the circular for old field books, maps, profiles, and plans, and for the addresses of retired officers and employees, or of contractors who may have done work for the road formerly.

From the railway company's point of view, it is, of course, desirable to present these matters to the Federal Valuation Engineers to enable them to form a fair estimate of what it would cost to replace the road at the present time, as well as the estimate which the law requires of the original cost of construction. The very fact, however, that a knowledge of these items depends largely on personal recollection makes it clearly evident how futile is the task of trying to obtain a complete history of construction and betterment expenditures on railways built a half century or more ago, as were a large

part of the lines comprising the Central Railway of New Jersey system.

How few of the engineers and contractors, who were in responsible charge of work even 30 years ago, are still living and able to furnish authentic information. Even when such men can be found, their recollection of events occurring so long ago, must of necessity be more or less vague and hazy, and will be an uncertain foundation on which to base a dollars-and-cents estimate of cost.

There is, however, another and still more important aspect of this search into past history. The ultimate purpose of the valuation is doubtless to furnish an authoritative basis for fixing railway rates.

Now a very little study and in fact the common sense of the individual indicates that a railway is entitled to earn a fair income on what its property is worth today, not on what it may have originally cost. This is merely applying to railways the rule which applies to all other lines of business and industry. It is the universal rule that the income from a property—be it a farm, a factory, a mine, a house or a going business—depends on what it will now earn in net income, not at all on what it may have originally cost the owner. Of course, railway rates cannot be based on a valuation governed by net earnings, since the rates themselves determine the earnings, but they can fairly be based on what the railway's entire property as it stands today as a going business could be reproduced for under present conditions, since this is the condition under which other industries are carried on.

A manufacturer, for example, buys a complicated and expensive labor-saving machine as soon as it appears on the market. He thereby gains such an advantage over his competitors that for a year or two he is able to make very large profits. At the end of that time, the machines are produced in such large quantities that his competitors can buy them at a comparatively low figure. He must meet their competition, based on low-cost machinery, and reduce the prices of his goods to compare with their quotations, regardless of the prices he may have paid for his own machines.

If an inventory of his plant were made, the machines would be appraised at what they could be replaced for, no matter what fancy price may have been paid for them originally. Similarly, the owner of a piece of real estate can obtain a rental for it based on its present selling value. This value may be several times as much as he originally paid for it, or on the other hand, it may be very much less.

So a railway company may, in the early years of its history, have spent a vast amount of money in excavating a hard rock tunnel with hand drills and black powder. It is entitled today to earn interest only on what the tunnel could be built for with modern machinery and dynamite. On the other hand, it may have done a large amount of work in its original construction with very low-priced labor or with convicts, whereas today the restrictions of the labor unions or other economic conditions would make the reproduction of the same work twice as costly. The true valuation of its property is the valuation at which it could be replaced under present-day conditions.

So with the real estate that the railway company owns and uses in its transportation business. This may have been secured originally for a nominal consideration, or even given outright by a municipality for use as terminals. The railway is nevertheless entitled to earn an income today on the present value of this real estate, based on what it would cost at present to acquire it. Of course the rule works both ways. Some of the real estate now held by the railways, owing to business and residential changes, is worth less than its original cost.

The economic basis for this rule with reference to valuation lies in the fact that it applies to the public utility corporations the same rule that is applicable to all other industries in which free competition prevails. If it were indeed possible to have free competition in the operation of public utilities, then at any time when a railway charged exorbitant rates a competitor could build a line alongside and could base its rates on the cost of its new construction, which would compel the reduction of rates on the old line to that standard, no matter how much more costly the old line was to build. The rule, therefore, simply aims to compel, by process of law, what would take place through the natural force of competition, were the business one in which competition could prevail.

We are aware that there are strong influences in favor of the other plan of valuation, by ascertaining what the company has actually expended in the creation of its property and upon improvements thereto and taking this sum less depreciation as the value of the plant on which it should be permitted to earn an income.

Were it possible to ascertain these historic facts with anything like accuracy, and if the company had been under public control as to rates, service and expenditures from its establishment, much might be said in defense of this plan. But these conditions obtain in few cases. Many railways were originally built by construction companies, which were organized for the express purpose of making a large profit on the difference in the price paid by the railway company and that received by the actual contractor. A part of this profit may even be legitimate as a part of the necessary promotion expense in bringing the railway into being; but it is not to be believed that the public will stand for rates which make the profits reaped by dead financiers a generation ago a part of the permanent capitalization on which rates are to be based.

The influences which carried the Federal Valuation act through Congress, in fact, bitterly opposed this very thing. The idea that the present railway capitalization represented in large part "dead capital" and not present values, was the impelling motive in bringing about the passage of the act. If therefore, the historic basis should be used for railway valuation instead of the replacement basis, there is danger that the whole work may lose its authoritative character and that the public may refuse to accept it as fair.

We freely admit that the unearthing of past records, showing difficulties and extraordinary expenses in connection with the work, may have a certain value in making the Federal Valuation Engineers give fair allowance in their estimate of replacement value for those extraordinary items in connection with construction, which so often play a large part in increasing the final cost over the original estimate. But to attempt to make a complete valuation on the historic basis is attempting the impossible in most cases and even if it were fully determined, the public would discard it as unfair.

Letters to the Editor

Experience with Concrete-Pile Foundations in the Detroit Clay

Sir—The article on "Foundation Design, Michigan Central Railroad Terminal," in your Oct. 1 issue, has been construed by some to mean that no concrete piles were found which could safely be expected to carry a load of 20 tons each. This was not the conclusion drawn by the Michigan Central R.R. as is evident when it is known that on a portion of this terminal Raymond concrete piles

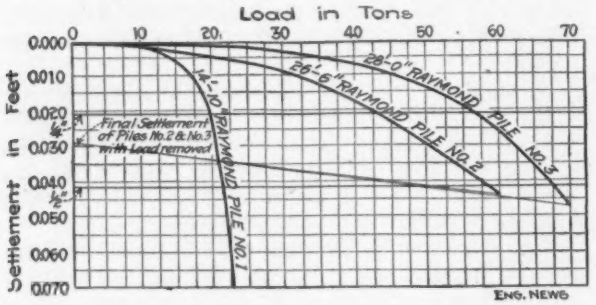


FIG. 1. LOAD-SETTLEMENT CURVES FOR THREE RAYMOND PILES, IN TESTS FOR MICHIGAN CENTRAL TERMINAL FOUNDATION

Pile 1 was short, being driven through hard-baked crust on surface, but was tested after hard rain. Piles 2 and 3 were driven in pits excavated through surface crust. The final load per square foot of friction surface was nearly the same for the three piles:

Pile	Friction Area, Sq.Ft.	Final Load, Lb. per Sq.Ft. Friction Area
1	39.50	1064
2	93.50	1230
3	100.25	1300

were used on the recommendation of G. H. Webb, Chief Engineer, under the above mentioned loading.

While some types of concrete piles seemed unadapted to the local soil conditions, the curves in Fig. 1 herewith will show that 20 or even 30 tons could be safely placed on the tapered piles tested, provided, of course, that they were driven to a reasonable depth, which in this locality was from 20 to 30 ft.

Pile 1 was driven under unusual conditions in that the surface of the ground consisted of hard-baked crust caused by an extreme drought which occurred just previous to this time. Piles 2 and 3 were driven in shallow excavations which penetrated this crust. Between the time of driving Pile 1 and the placing of the test load, the crust was thoroughly soaked and softened by abundant rain, so that the conditions when the load was applied were similar to those under which the two other piles were driven, after the upper crust had been removed. This short pile is therefore interesting, not for the total load carried, but for the relative load, i.e., the load carried per square foot of lateral surface. This, as shown below the table of curves, is remarkably close to the frictional value of the two longer piles.

The cost of placing concrete piles, however, together with the fact that there was some doubt as to whether the piles could be driven to a sufficient depth in the large piers required, on account of the extraordinary noncompressibility of the soil, made the adoption of the mat foundation economical, as stated in your article.

The oily gray clay under the Michigan Central Terminal is much more dense than the general soil of the Detroit district. The geological formation is very similar, however, to that found for a considerable distance from this point along the shores of the Great Lakes. Fig. 2 shows the character of this soil, which is so tough that it has to be actually cut out, and handled with a fork (shown in the photograph). The holes in the clay made by the fork can be clearly seen even though the clay has been exposed to a hard rain for several days. In time, however, this material will "weather" and run into a solid mass again. The material under the downtown district of Detroit is much softer and is considered on the whole much less trustworthy for building purposes. In the last few years over 60,000 ft. of Raymond concrete piles have been driven in Detroit, under 12 buildings. None of these piles is loaded less than 20 tons and the majority carry 30 tons. In some cases the calculations have shown that the actual load on the piles after the building had been erected and filled was 35 tons, but in no case has any appreciable settlement been evident or the slightest difficulty experienced with the foundations. Engineers

FIG. 2. SLICES OF CLAY SUBSOIL EXCAVATED AT MICHIGAN CENTRAL TERMINAL SITE

(Slices excavated by drawknife and handled with one-tined fork shown in view. The pile was exposed to several days' rain before the picture was taken, but the slices still show the fork holes.)

therefore feel justified in using 30 tons as a safe load to allow on tapered Raymond piles.

In 1909, the Buhl Mfg. Co., of Detroit, built their five-story warehouse on Raymond concrete piles, loading them to 30 tons each. Even though their loads have been increased over what was originally contemplated, no settlement has been found. This was the first building in Detroit to be built on concrete piles. Since then, Ray-

mond concrete piles have been used under the following buildings:

Date	Name	Loading, Tons per Pile
Dec., 1910	Buhl Malleable Co.	25
May, 1911	Boyer Campbell Warehouse	30
July, 1911	Free Press office building, first half	30
Aug., 1911	Kiefer Building, office and store building	30
Aug., 1911	Murphy Iron Works, office building	25
Mar., 1912	Free Press office building, second half	30
Mar., 1912	Murphy Iron Works, factory	25
July, 1912	Central Heating Co., power plant	30
Jan., 1913	Standart Bros. warehouse	20-30
Jan., 1912	Dodge Bros. warehouse	30
Sept., 1913	Michigan Central R.R. Co. station	20

MAXWELL M. UPSON,
Secretary & Gen'l Manager, Raymond Concrete Pile Co.
140 Cedar St., New York City, Nov. 4, 1914.

Flat Slab Indulgences

Sir: In your issue of Sept. 24, 1914, p. 632, there appears the new Chicago building code as applied to flat slabs. Some uncertainties in the ruling for the four-way system should be pointed out:

Strip *A* (a strip crossing the columns and of a width equal to one-half the panel length) is said to have a negative moment "at the edge of the column cap or over it" with a coefficient $^1/_{15}$. Is the designer permitted to make his own selection as to the location of this bending moment and if he selects "over it," is he permitted to consider the column shaft as part of his resisting section—an inverted T-beam of any depth desired?

Another feature of the code is the entire absence of any provision in columns for the tremendous bending moments that they must take unless the load happens to be balanced. It is true that the code says: "Special attention shall be given to the design of the column capital in considering eccentric loads;" but how on earth can a column capital have eccentric loads without the same being taken by the column shaft?

How any designer can compute tremendous bending moments in column capitals and then totally ignore these in his column shaft is a mystery. And yet this is the common way to design a flat-slab system, and it is sanctioned by this code. The proof that this code allows a bending moment, *even in wall columns,* is found by comparing the moment coefficient for wall panels supported by columns and girders and that for panels on brick walls. Another proof is in the placing of the point of inflection one-quarter of the distance center to center of columns.

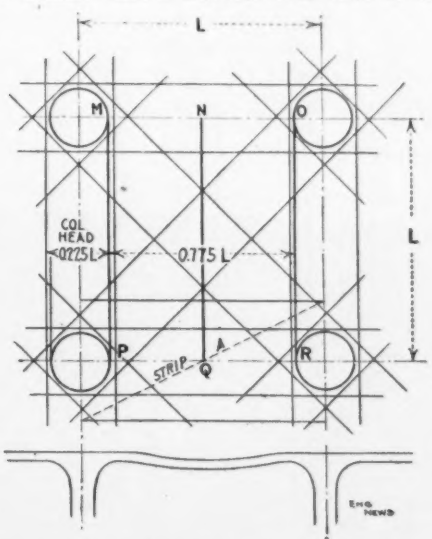
The bending moment in Strip *A* is found to be $^1/_{80}\ wL^3$ at middle span, where w = total load per sq.ft. on the slab. (The coefficient $^1/_{80}$ is brought in by using w as the load per sq.ft. in place of using W as the load per lineal foot on a strip $\frac{1}{2}\ L$ in width.) Now in the rectangle *MPRO* (see accompanying cut) we have a slab which, for purposes of discussion, we may consider supported along *PM* and *RO*. In the section *NQ* of this slab there are three complete bands of rods, but since two of these are at 45°, they will be equivalent, if fully stressed, to 1.41 bands. Hence the full resisting value of the bands of rods, assuming all bands alike, is 2.41 times that of one band, in the section *NA*, or $2.41 \times {}^1/_{80}\ wL^3 = 0.03\ wL^3$.

In the slab *MPRO*, the bending moment at *NQ* plus that at *MP* or *OR* must, by the theory of flexure, be equal to the product of the load on the span and one-eighth of the span length, or $w \times 0.775\ L \times L \times \frac{1}{8}\ L \times 0.775 = 0.075\ wL^3$. The minimum value of the moment either at *MP* or *NQ* is then one-half of this, or $0.0375\ wL^3$. In each of these sections named, there is the same reinforcement. Taking, then, the best possible condition, the actual bending moment at its minimum is 25% greater than that given by the code. A similar analysis of the wall-panel moment reveals a somewhat more excessive divergence.

The foregoing presupposes just the proper balance of load over the columns and just the proper deflection to give exactly equal moments at the several sections considered. These are not possible conditions, except for one arrangement of loading; they are, however, the most favorable assumptions possible for the four-way system.

Building codes allow a moment coefficient of $^1/_{12}$ for interior slabs. Introducing $0.775\ L$ as the span length, this would be $0.5\ wL^3$ as the moment. Thus the plain-slab designer would have to use 67% more effective steel reinforcement than the flat-slab designer.

The advantage that this code gives to the flat-slab bidder is obvious. It has never been shown, and in fact it is not claimed that a flat-slab over rows of columns



is better conditioned than the same slab on parallel lines of girders. This tremendous advantage would, therefore, appear to be due merely to the placing of some of the rods in a diagonal direction.

This code appears to have been worked up from data obtained by testing floors in buildings and measuring deflections and steel deformations. This kind of testing and deductions made therefrom are misleading and unfair to other systems of design for several reasons:

(1) Only a portion of the floor is ever loaded, and in the nature of the construction the surrounding slab offers large aid to the part tested. Other systems are based on tests of isolated parts.

(2) The tests made are lower stories in buildings where the columns are large and are capable of giving great aid to the slabs not only because of their size, but also because they themselves are only carrying a small part of their load.

(3) The measurements taken are greatly influenced by the tensile strength of the concrete. Users of other systems are compelled to ignore tensile strength in concrete.

EDWARD GODFREY.
Monongahela Bank Bldg., Pittsburgh, Penn.,
Oct. 16, 1914.

The Yale Bowl; an Amphitheater of Earthwork

By Thomas C. Atwood*

SYNOPSIS—A football field with a complete ring of seatbanks, of 61,000 capacity; field excavated 27 ft. in a flat plain, and surrounded by an embankment built of the spoil; access to field by 30 tunnels through bank; inner face of bank covered with seatbanks, of concrete below original surface and wood above; wooden portion to be replaced by concrete next year.

Yale is building a new colosseum at New Haven to seat 61,000 spectators. It is built on a different plan from that used on previous structures of this type in this country, being practically a mass-concrete and earthwork structure with the seat slabs laid directly upon the earth, instead of the usual reinforced-concrete slab supported above ground on beams and columns. It is built on a level plain in a similar manner to a cut-and-fill reservoir, the earth being excavated to a depth of about 27 ft. in the center and the material used to form an oval-shaped embankment rising to about 27 ft. above the natural ground and completely surrounding the playing field.

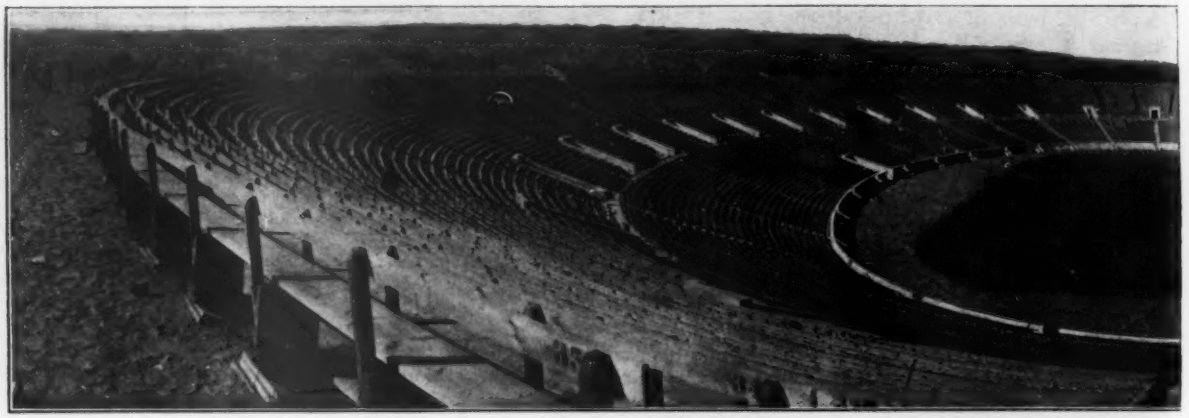


Fig. 1. The Yale Bowl, a 300x500-Ft. Field, Surrounded

The "Bowl" occupies a field of 25 acres, ample room being allowed for entrance and exit of the large crowds. The outside dimensions of the structure are 750 by 950 ft., and the playing field is 300 by 500 ft. The main axis of the field lies about NW and SE, so that the afternoon sun in the fall will be at right angles to the side lines and will not shine in the players' eyes.

It may be of interest to note that the largest of the ancient amphitheaters, the Colosseum of Rome, had outside dimensions of 510 by 615 ft., with inside dimensions 177 by 281 ft., while the great structure at Pompeii, which the "Bowl" most resembles, is 342 by 444 ft. outside and 115 by 218 ft. inside. The seating capacity at Pompeii was 20,000 and that of the Colosseum 50,000, but the latter was four stories high.

The location is ideal for such a structure with seats built directly on the embankment, the material being a coarse sandy gravel giving perfect natural drainage. It was realized that there will probably be some slight frost action (expected to be very slight owing to the coarseness of the sand), but this and also the danger of unequal settlement in the embankment has been provided for by making the concrete blocks of the seating structure quite small and reinforcing them heavily. The embankment is faced on the outside with grass, the slope being approximately 1 on 2. A retaining-wall holding the foot of the slope prevents outsiders from climbing up the bank.

The promenade around the top of the bank and the 30-ft. walk around the outside of the Bowl have 2-in. surfacing of broken stone with the interstices filled with screenings, all watered and rolled.

Retaining-Walls

The outer retaining-wall is of the gravity type and is 9 ft. high above ground. It has a gutter cast in the top for carrying off the surplus water from the bank above it. The inner retaining-wall, which defines the playing field, is also of the gravity type and has also a gutter cast in the top for carrying off the water falling on the seats.

Both the inside and outside walls have been built in short lengths with pilasters between, the pilasters being built later and acting as expansion joints.

The public entrances are tunnels set back into the bank with curved walls connecting their portals to the outside wall.

The inner retaining-wall is surmounted by a concrete parapet wall 27 in. high, which serves as a fence between the seats and the field and is so designed as to appear to heighten the main wall from the field side and thus give a better architectural effect.

The surface of the concrete has been given a rough finish by rubbing up with a wooden float as soon as the forms were removed, except that the pilasters and coping of the outside wall were finished up smooth.

*Supervising Engineer, Yale Committee of Twenty-one, Inc., New Haven, Conn.

Tunnels

There are 30 tunnels provided for the entrance of spectators, all running from the ground level outside to about the middle of the bank of seats inside. These tunnels are 7 ft. wide and 8 ft. high inside. They were built in the open and the embankment built around and over them. The walls of the tunnels are 15 in. thick and the roof 8 to 15 in. thick. The roof is waterproofed with three layers of tarred felt and one layer of "tartex," each layer being thoroughly mopped with pitch before the next was put on, while a single layer of pitch was mopped onto the sides. The tunnels average about 140 ft. in length, some being longer than others on account of the fact that the outside ground level on the northerly side is lower than on the southerly side, thus lengthening the outside slope and consequently the tunnels.

There are two tunnels which run from the outside ground level to the playing field. One of these, the Main Tunnel, is 15x10 ft.; is on a grade of about 7½%, and has an 8-in. concrete pavement. It will admit the working force to the field and will also serve as an exit for processions and for the large crowds which will come down onto the field after the games. The other, the Players' Tunnel, 10x8 ft., gives access to the players from the south side where the visiting team will have its quarters, and where the large clubhouse for the accommodation of all teams will be built.

All tunnels are lighted by electricity.

Seating Structure

The seating structure consists of concrete slabs, as mentioned above, laid directly on the surface of the ground with steps cast in the top and with wooden benches supported over the edge of the concrete steps by steel standards. The present contract provides for placing the permanent seating structure up to the original ground level only, and placing a temporary wooden seating structure above that level. It is expected that this temporary structure will be used only for the Yale-Harvard game on Nov. 21, 1914, and that next year it will be removed and the permanent structure carried to the top of the bank. For the opening game over 75,000 applications for seats were made and in order to accommodate as many as possible 7500 additional temporary seats are being built on the promenade at the top.

The concrete slabs vary in length from 8 to 17 ft., most of the slabs being under 13 ft. long. All except those on the cross-aisle are three steps wide, or 8 ft. overall. They are reinforced in both directions and both top and bottom so as to carry their load if supported only at the edges or only in the middle. One radial joint in the seating slab between each pair of tunnels is filled with Carey's "Elastite" to provide for expansion.

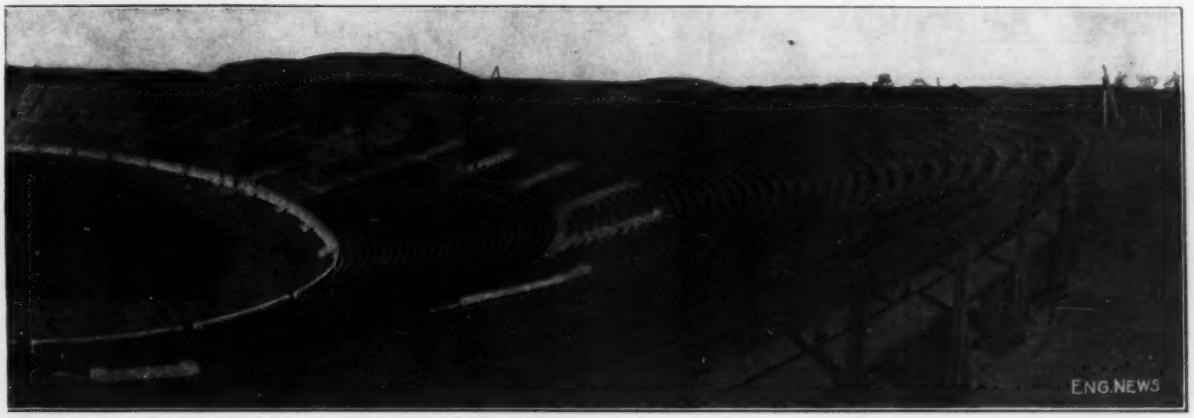
The surface of the steps, both tread and riser, has been given a smooth sidewalk finish with a ½-in. mortar coating placed integral with the concrete. The mortar was colored with lampblack to a dark bluestone, to prevent the glare from the natural cement color.

An aisle leads directly down from the inner end of each tunnel to the playing field, a flight of steps being provided at the foot of the aisle. A cross-aisle connects the inner ends of the tunnels and from this two aisles extend to the top of the bank of seats between each pair of tunnels.

Seats

The benches are made of 1¾x9¾-in. (finished) planks supported on steel standards or brackets and provided with a back rest consisting of a 1⅛x4¾-in. strip supported on wooden posts bolted to the back side of the steel standard. The steel standards are bolted to the concrete by ⅝-in. Tobin bronze U-bolts. All steelwork is galvanized or sherardized and then painted with a rust-preventive paint. The seat plank is set so that its front edge projects 4½ in. in front of the concrete riser, giving plenty of room for the heels, and it is set so as to slope backward at such an angle so as to give the most comfortable seat. The seat planks are fastened down with lagscrews from underneath so as to leave the top of the seat smooth. The top of the plank is shaped to a special curve determined by experiment and this is thought to be a great improvement in the making of wooden benches. The back rest is curved on the front side so as to have no projecting corners.

The wood for these seats is Douglas fir. This was decided upon after an exhaustive investigation, it being desired to obtain a wood which has a good appearance, which can be obtained in clear lumber and with all vertical grain (to eliminate the picking up of splinters on the top of the seat), and which is as durable as possible.



BY 61,000 SEATS (FROM A PANORAMIC PHOTOGRAPH)

The only woods to fulfill all of these conditions were Douglas fir, Western hemlock and redwood. Redwood was eliminated because it is liable to stain clothing when wet and Western hemlock because it is less durable than the Douglas fir and delivery could not be guaranteed. The only defect allowed in the Douglas fir was a reasonable number of pitch pockets, and trouble from these was eliminated by having the wood kiln-dried.

The wood has been treated for preservation by giving it two coats of Chinese wood oil, one before erection and one after.

The temporary benches were made similar to those last added to the old wooden football stand, and have a $1\frac{1}{8}$x$9\frac{3}{4}$-in. spruce seat plank, and $\frac{7}{8}$x$3\frac{3}{4}$-in. spruce back rests. A press box has been built accomodating 250, and provided with ample telephone and telegraph service.

Playing Field

The playing field was built on a bed of sand 29 ft. below the original surface of the ground. Special attention was given to designing a field which should be as perfect as possible. It was feared that with the perfect drainage underneath, and only sandy loam to use for surfacing, trouble might be experienced with the field drying out. This condition was met by putting on an extra-thick layer of loam (total thickness 18 in.), and mixing into the top layer humus, which is practically a natural leaf mold and has the property of retaining moisture a long time.

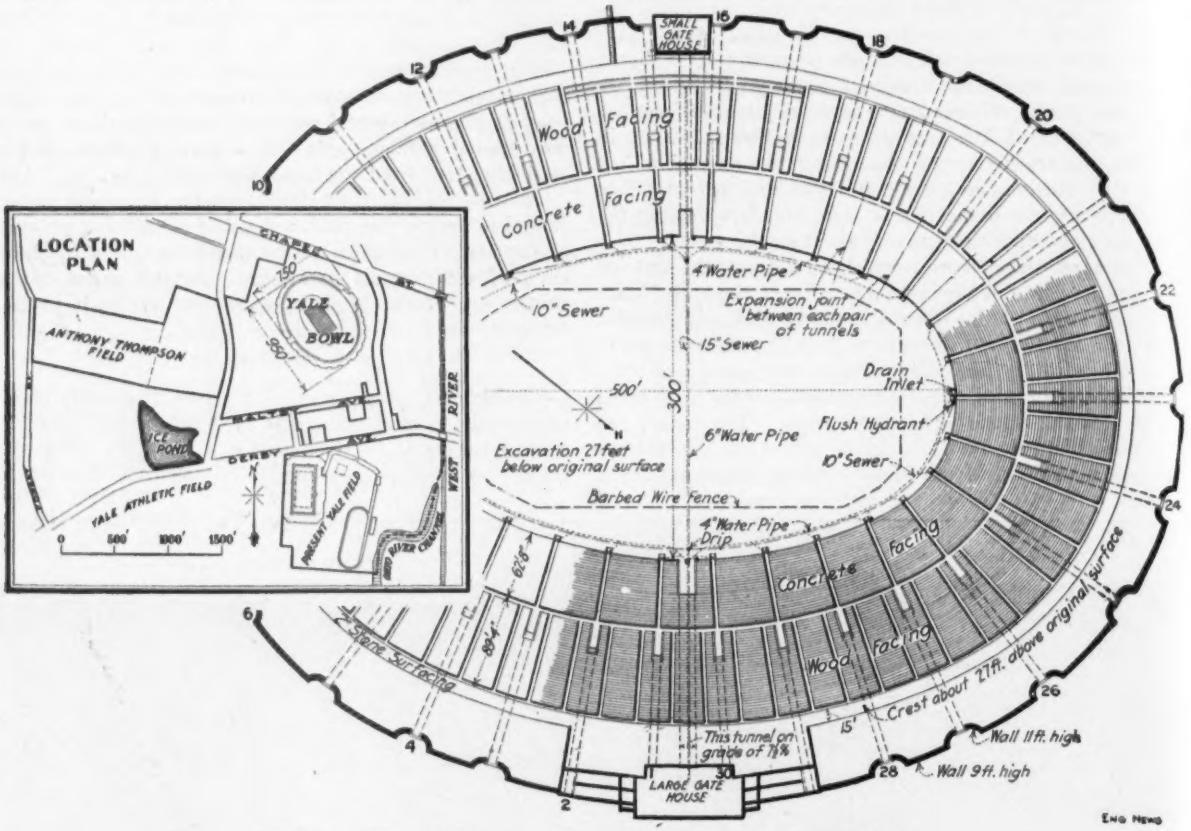


Fig. 2. General Plan of Yale Bowl, and Location Plan

The entire field (and the pipe trenches) were first heavily watered to settle any place which had been accidentally dug below grade, and then an 8-in. layer of black loam was spread and rolled with a 5-ton roller. A second layer was then spread and rolled likewise and top-dressed to a true surface 17 in. above subgrade. An inch of fertilizer humus was applied and harrowed in, and the surface rolled with a hand roller. Then 2 in. of sod was put on, the field being left 1 in. high to provide for anticipated settlement. The field was turfed the latter part of August except for working space left outside of the gridiron near the wall. Screened loam was spread over the turf and raked in. No further rolling was done until the last of October, when the 5-ton steam roller was put over the field before any practice was allowed on it. The result has been a perfectly smooth field with a fine springy turf.

The field is crowned 12 in. between side walls, 5 in. of this being between the side lines of the gridiron. The crowning was made with a special curve so as to give reasonable drop between the center and side lines without having an excessive drop between the side lines and the wall; it has worked out very well.

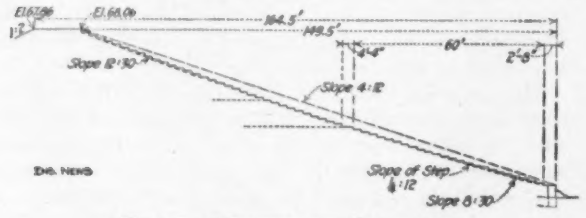


Fig. 3. Profile of Seatbanks

Architectural Features

The purely architectural features are in the two large gate-houses, which are expected to be built next year. One of these, the Main Gate House, is 96x47 ft., 42 ft. high, and provides quarters for the home team and for the ticket department. The Small Gate House is 60x43 ft. and 40 ft. high, and provides quarters for the visiting team.

A large stairway is to be built on either side of the Main Gate House, from the top of the bank to the ground, this together with the gate-house providing an impressive feature at the main entrance.

The tunnel portals have been worked out very effectively.

Water-Supply and Drainage

A 6-in. main connected with the city water system is laid into the playing field; a 4-in. main is run around the field and another 4-in. main around the outside of the Bowl. Numerous flush hydrants have been placed to give short lines of hose (2-in.) for watering the grass.

A vitrified drain is laid around the outside of the Bowl and one around the playing field, both emptying into a main drain running to the West River. The water falling upon the seats runs down over the steps to a gutter just in front of the bottom riser, from which it is discharged under the steps leading to the playing field. A small catch-basin located under these steps takes this water and also that which runs off from the playing field.

Automobile Parking Fields

Among the many problems connected with this work, that of handling the enormous traffic was not the least, and the automobile traffic is the most troublesome. The surplus excavation from the Bowl was placed upon the meadow between Yale Ave. and the West River, converting this swamp into 12 acres of good level land, admirably adapted for automobile parking and well above all but extreme floods. This space has been laid out in streets leading to a boulevard along the river, and footpaths between the streets lead toward the Bowl, the arrangement being such that the foot passengers do not cross any street on which the autos travel. Another even larger parking space is provided west of the Bowl.

Fig. 4. General View during Construction of Seatbanks

Contracts

The work has been done under three contracts, all of which were let to the Sperry Engineering Co., of New Haven. The first contract was let in July, 1913, and comprised the main excavation and embankment, the water-supply and drainage systems, the tunnels, and outer and inner retaining-walls. The second contract, let in July, 1914, comprised the seating structure and the parapet walls. The third contract, let in September, 1914, comprised the finishing up of the exterior grading and laying of macadam walks. Work was started on all of these contracts immediately after letting, and they are now practically completed.

Hon. T. De Witt Cuyler is Chairman of the Yale Committee of Twenty-one, Inc., for whom the Bowl is being

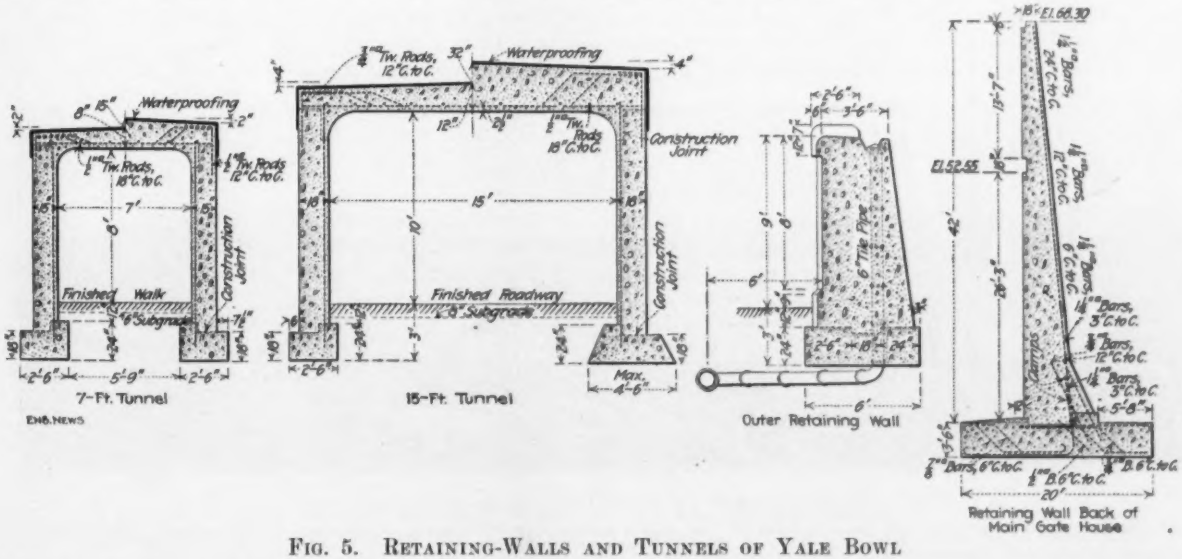


Fig. 5. Retaining-Walls and Tunnels of Yale Bowl

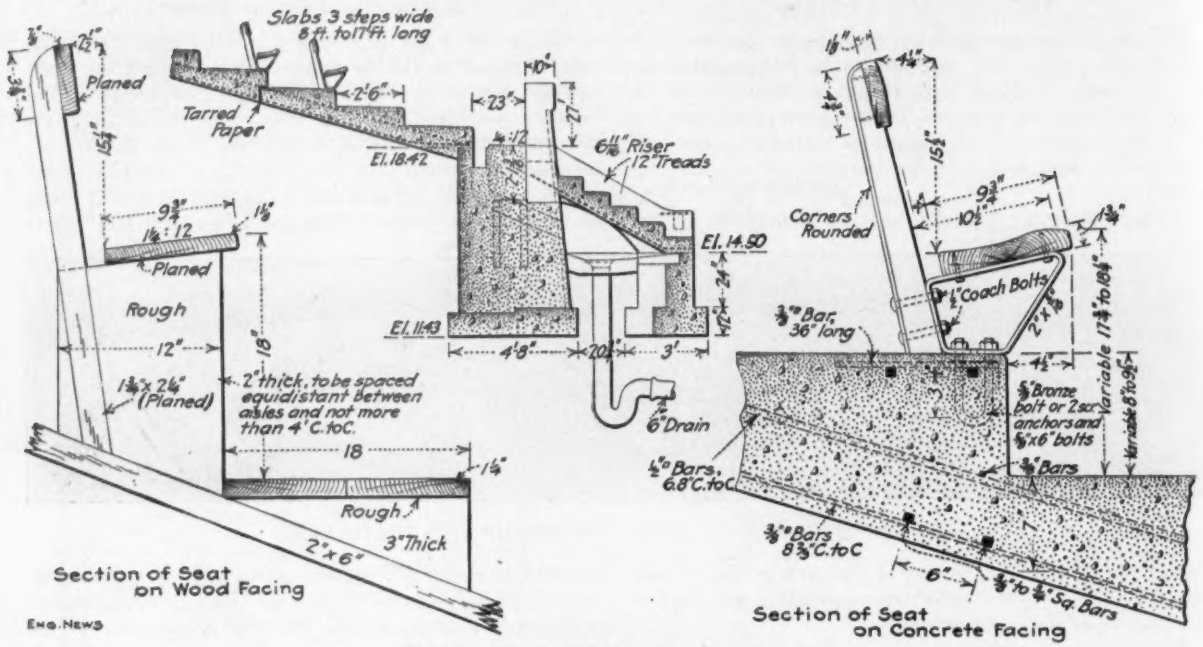

Slabs 3 steps wide 8 ft. to 17 ft. long
Planed
Tarred Paper
El. 18.42
6 11/16" Riser 12" Treads
El. 14.50
El. 11.43
Rough
2" thick, to be spaced equidistant between axles and not more than 4" C. to C.
1¾" x 2¼" (Planed)
18
3" Thick
2" x 6"
Section of Seat on Wood Facing
Eng. News
Corners Rounded
½" Coach Bolts
⅜" Bar, 36" long
⅝" Bronze bolt or 2 screw anchors and ⅝" x 6" bolts
⅜" Bars
½" Bars, 6.8" C. to C
⅜" Bars 8⅜" C. to C
⅝" to ¾" Sq. Bars
Section of Seat on Concrete Facing

FIG. 6. SEATBANK SLAB AND SEATS

(Seating plank in permanent part of bank was shaped to special curve determined by experiment. The seats are fitted with backs—another unusual feature.)

built. The writer is Supervising Engineer, and C. A. Ferry, who conceived the original design of the Bowl, Resident Engineer. Edward G. Williams, of New York, is Advisory Engineer and Donn Barber, of New York, is Consulting Architect. David Daggett, of New Haven, Secretary of the Committee of Twenty-one, is Chairman of the Structures Committee. The playing field and details of the seating structure have been under the personal supervision of Everard Thompson, Assistant Secretary.

Clearing the Slide in the Panama Canal

We briefly noted on p. 852 of our issue of Oct. 22, the closing of the Panama Canal through Culebra Cut on Oct. 14 and the opening of a channel through it in five days by the canal dredges. A fuller account of the slide and its removal is given in the *Canal Record* of Oct. 21. We abstract it as follows:

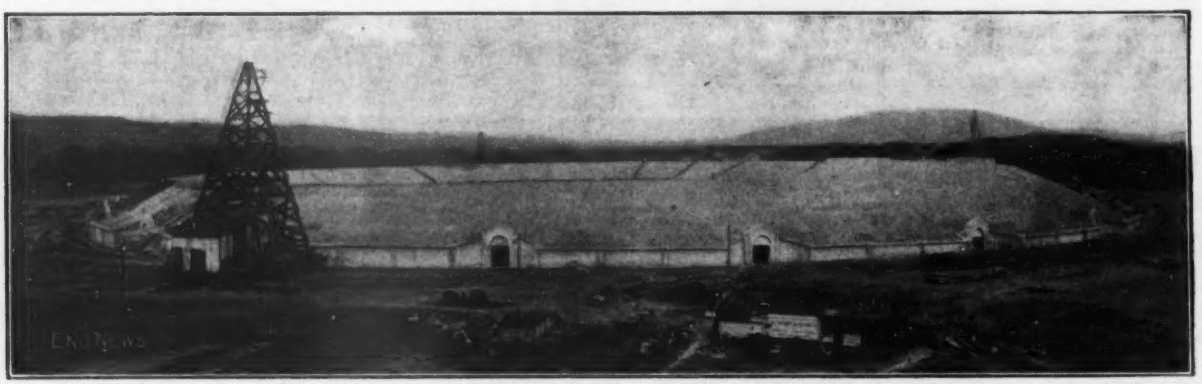


FIG. 7. EMBANKMENT OF YALE BOWL DURING CONSTRUCTION

(At the left is one of the two head-towers of the power scraper by which the earthwork was handled. Contractors, Sperry Engineering Co.)

A large slide on the east bank of Culebra Cut, directly north of Gold Hill, moving between 5 p.m., Oct. 14, and 9 a.m., Oct. 15, carried about 725,000 cu.yd. of earth and rock into the canal prism, and blocked the channel for 1000 ft. to the passage of vessels larger than towboats, causing the suspension of traffic.

The big dredges were working at Cucaracha slide, south of Gold Hill, at the time the slide started, and with commendable foresight on the part of Messrs. Comber and Macfarlane, steps were taken to move them northward; but for this action, the results secured could not have been accomplished, as the condition of the channel was such that loaded barges could not be passed through the slide.

Electric Storage Battery Vehicles for the collection of garbage and refuse in the City of Paris vary from 1½ tons to 5 tons capacity and are equipped with Tudor storage batteries. The battery is of 44 cells and has a capacity of from 200 to 435 amp.-hr. according to the size of the car. The run on a single charge varies from 25 to 50 miles. There are 100 vehicles of this type used in Paris, made by the Fram Co., a number of which are described in "The Engineer" of Oct. 23.

The dredges were worked under triple shift. The 15-yd. dipper dredges "Gamboa" and "Paraiso" and the 5-yd. dipper dredge "Mindi" began excavation at the north side of the slide during the night of Oct. 14-15, while the mass was still in motion. The dipper dredge "Cardenas" was added to the fleet on Oct. 15, and during the 16th an extension of discharge pipe was laid from a point opposite Cucaracha slide, which allowed the pipe line suction dredge "No. 86" to take part in the work.

The channel was cleared sufficiently by noon of Oct. 20 to allow the passage during the afternoon of seven vessels, which had been delayed at the south end of the canal. The actual passage of the seven through the cut occupied about four hours; they followed each other at intervals of about half an hour, propelled by their own power, but passing the slide under the control of a tug fore and aft, to hold them to the course. Thirteen vessels were awaiting passage from the Atlantic entrance; nine of them were transferred to the anchorage basin in Gatun Lake, south of Gatun Locks, on Oct. 20, and are being handled through the cut today.

The slide which blocked the canal is 2100 ft. long, and broke back about 1000 ft. from the center line of the channel. It occurred in a part of the bank, formerly involved in the east Culebra slide, and is designated as the "New Culebra" slide. The old slide appeared to be dead, and the channel opposite it had been cleared to almost full width and depth. At the present time, no further movement is indicated, but practically all of the 725,000 cu.yd. involved in the movement of Oct. 14-15 will have to be dredged from the prism, which may cause further motion. The material is masses of rock and earth, in about equal proportions.

Following the preliminary survey made on the morning of Oct. 15, after the slide had come to rest, it was estimated that, unless further movements occurred, the channel could be opened in one week. A still later estimate set Oct. 22 as the first day on which vessels could pass the slide. The performance of the dredging forces in clearing the channel in two days' less time than was believed to be necessary indicates the fitness of the equipment and the loyal persistence of the personnel.

The excavation accomplished by the dredges at the base of the slide, in periods ending at 8 a.m. of each day named, was, in cu.yd.:

Dredge	15th	16th	17th	18th	19th	20th	Total
"Gamboa"	3935	5,160	6,175	6,910	7,800	5,775	35,755
"Paraiso"	4150	6,900	7,625	7,600	6,720	4,975	37,970
"Mindi"	1845	1,000	2,403	2,709	1,640	2,137	11,734
"Cardenas"	....	3,027	3,251	2,031	3,210	2,052	13,571
"No. 86"	....	....	3,825	5,850	6,250	4,650	20,575
Total	9930	16,087	23,279	25,100	25,620	19,589	119,605

The maximum day's output was 25,620 cu.yd. in the period ending at 8 a.m., Oct. 19, or Sunday, when the dredge and towboat crews appeared for duty, without orders or instructions.

On Oct. 31 another slide occurred in the same material north of Gold Hill and blocked the Canal until Nov. 4, when the dredges had cleared the cut sufficiently to allow vessels to pass.

Defeat of Municipal Bond Issues at Dayton, Ohio

The defeat of bond issues for grade-crossing elimination, a municipal electric-light plant and parks and playgrounds by popular vote at Dayton, Ohio, on Nov. 3, was caused by a number of conditions of more than local interest. These conditions are set forth in the following notes sent to ENGINEERING NEWS by S. H. Ankenny, Publicity Manager of The Greater Dayton Association:

Inasmuch as the "Dayton Plan" of municipal government is a subject of great interest at the present time, you may be interested in knowing the result of the first election, at which several municipal issues were at stake, since this form of government has come into power here.

About a month ago, the city commission put up to the people for ratification at the election on Nov. 3, two bond issues: one for $250,000 to be used in buying several dumps and improving them for parks and playgrounds, the other for $1,000,000 to be used in defraying the city's share (35%) of the cost of elevating the joint railroad tracks through the heart of the city.

At about the same time the socialist party, which has been against the new form of government from the first, petitioned the city commission to bring before the voters a bond issue for $500,000 to construct and operate a municipal electric-light plant. The city commission turned this proposition down, believing it would be financially inexpedient to engage in the electric-light business in competition with a private corporation which is now rendering adequate service at a fairly reasonable rate. This corporation has $8,000,000 invested in its local plant and, consequently, a half-million dollar plant would be at a great disadvantage and would be inadequate to meet the needs of all but a small portion of the city. The socialists took the proposition over the heads of the city commission by securing enough signatures to their petition to demand a referendum.

At the same time, the Greater Dayton Association began an active campaign for the passage of the bond issues for parks and playgrounds and grade-crossing elimination, and the defeat of the bond issue for the municipal electric-light plant. The vote Tuesday had the following results:

	For	Against
Parks and playgrounds.....	9,784	16,931
Grade-crossing elimination.....	10,453	15,871
Municipal light plant.....	9,193	13,174

From these results it is seen that all of the propositions were defeated. While the city commission lost its proposed bond issues for parks and playgrounds and track elevation, it secured the indorsement of the voters in turning down the municipal electric-light plant.

The one great factor in the adverse vote on the bond issues was the present business conditions and the feeling of financial stringency prevalent throughout the country. There was also sectional opposition, as some parts of the city were opposed to track elevation because the plan did not include the elimination of grade crossings in these suburban districts. Other parts of the city were well provided with parks and, therefore, took an independent attitude upon this question. The municipal light plant, of course, attracted a large number of voters who favor municipal ownership in any form without regard to the reasonableness of the question at hand.

The result of the vote is not considered unfavorable to the city commission. In fact, it puts the present administration in a better position than it was previous to the election, inasmuch as there has been considerable agitation for track elevation and parks and playgrounds, and now all responsibility for failure to secure these things has been placed upon the people at large. There would undoubtedly have been criticisms of the city administration if these questions had not been put before the voters at this time.

NEWS NOTES

Bridge Falsework Was Washed Out at the new Milwaukee Bridge over the Chehalis River, at Mays, Wash., on the Puget Sound & Willapa Harbor Ry. The accident was caused by a log jam.

A 6½-Ft. Rise in the South Canadian River carried out six bents of a timber bridge on the Rock Island Lines, at Bridgeport, Okla., on Oct. 25. Two other similar accidents have occurred this year at the Bridgeport bridge.

A Fire at the New York Dock Co., Brooklyn, N. Y., early on Nov. 9, destroyed a nine-story brick building which contained the machinery for operating two adjoining grain elevators. The origin of this fire is unknown, as was that of the destructive pier fire of the Sicula-Americana line ("Engineering News," Nov. 5), which occurred on Nov. 4, within 150 ft. of the present blaze. The damage caused by the New York Dock Co. fire is estimated at $100,000.

A Collision of Electric Street Cars at Chicago occurred Nov. 3 in the Van Buren St. tunnel under the Chicago River. The tunnel has grades of 6.32% on the west and 11.06% on the east (Engineering News, Sept. 13, 1906). A car that had just passed the center of the tunnel and started up the eastern grade was stalled by the trolley pole jumping off the wire. The rules require that in such cases the conductor shall go back to stop following cars, but in this case the conductor at once mounted to the roof of the car to replace the trolley. Owing to the steep grades, the roof of the tunnel hid the standing car from the motorman on the next car until it was too late to stop, and it is reported that the air-brake did not work properly. One man was killed and five persons were injured. The conditions of steep grades and heavy traffic in the three Chicago River tunnels of the street-railway system would seem to call for the installation of some automatic block-signal system to indicate to each car its clearance from the car preceding.

A Convention of Alabama City Officials has been called by the College of Engineering of the University of Alabama to be held at Tuscaloosa, Ala., Dec. 3-4, for the purpose of organizing a State League of Municipalities. Address George Jacob Davis, Jr., Dean, College of Engineering.

Buffalo, N. Y., Adopted Commission Government by about 15,000 majority on Nov. 3. The general principle was approved by a "public opinion" vote a few years ago, but it was not until 1914 that a commission charter bill could be got through the legislature. Even then, the bill was vetoed by the mayor, but the legislature overrode the veto. (Legislation affecting only one city in New York State goes to the mayor for action.)

A Third High-Level Bridge across the Cuyahoga River valley at Cleveland, Ohio, was authorized by a county referendum vote on Nov. 3. While it is expected that the Huron-Lorain Ave. route will be selected, the County Commissioners have asked the city and federal authorities to coöperate in picking out a route which not only will give a desirable crossing but will lend itself to the necessary straightening of the Cuyohoga River. The recent vote authorized a $5,000,000 bond issue.

Work on the Badin Hydro-electric Development of the Southern Aluminium Co., near Whitney, N. C., is reported to have been suspended, although in an advanced stage, on account of European war. As noted in "Engineering News," June 1, 1914, some 125,000 hp. was being made available for smelting operations. The project was being promoted by L'Aluminum Francaise and the engineers in charge of design and construction are reported to have returned to France.

The Ontario "Hydro-radial" Electric Railway Scheme, proposed to be built jointly by several municipalities and the Hydroelectric Power Commission (as noted in "Engineering News," April 23, 1914, p. 935) were approved on Oct. 19 at elections in 11 towns out of 13 involved. The interurban lines under discussion at present extend from Toronto to Newmarket and Port Perry, about 25 and 35 miles respectively. The construction work must wait on securing a promised provincial subsidy.

Stockton St. Tunnel Delayed by Strike—Work on the Stockton St. tunnel, San Francisco, described in "Engineering News," July, 2, 1914, p. 12, has been delayed by a strike of the local Plasterers' Union. This organization is dissatisfied that the tunnel is not plastered in accordance with the esthetic taste of the plasterers, who would like the city to pay an additional $3000 to give the interior lining a smooth finish, despite the fact that it will probably be lined with tiling in the near future.

Bonds for Sewage-Treatment Works at Norristown, Penn., were defeated by a popular vote of three to one, on Nov. 3. The vote appears to have been virtually a defiance of the Pennsylvania State Department of Health, which we understand had ordered the Borough of Norristown to provide sewage-treatment works. Had the bonds carried the works would have been built in accordance with plans prepared by George W. Fuller, of New York City. S. Cameron Corson is Borough Engineer of Norristown.

Prizes for Essays on Highway Construction have been offered by the Barber Asphalt Paving Co., Philadelphia, to students of American engineering schools. The prizes aggregate $1000 and are intended to promote study of highway problems to the end that students may be encouraged to enter this field of work. The subjects suggested cover a wide range: "Factors governing choice of pavement and road types," "an ideal paving program for a city of 25,000 population," "economics of highway construction," etc.

Freight Rates on Long and Bulky Materials were the subject of a hearing before the Interstate Commerce Commission at Chicago, Oct. 27. The hearing was attended by representatives of the railway classification bureaus, and by a score or more of shippers of iron and steel products. The railways desired that shipments of such articles as steel culverts, which are too long or too bulky to be loaded into a standard 36-ft. box-car, should be charged for at a minimum based on 5000 lb. for each article in each shipment. The shippers contended that the minimum weight of 5000 lb. should apply to the entire shipment and not to each article in it. The Commission has not yet decided he quesion.

A Tunnel in the City of San Francisco constructed by the California State Harbor Commission to provide a direct route from the Embarcadero to the Panama-Pacific Exposition grounds, was formally opened Oct. 31. The tunnel will be used by the State Belt R.R., and is intended primarily for freight traffic. It will form an important link between the United States transport docks and the main water front, for which reason the Government has agreed to pay $10 per car for all freight routed through the tunnel until the cost price of $219,233 has been paid. The Panama-Pacific Exposition has been given a rate of $5 per car for exhibits. The bore is 1500 ft. in length and extends from Van Ness Ave. through Fort Mason hill. Bates, Borel[illegible] & Ayer are the contractors.

The Reconstruction of the Missouri River Bridge of the Chicago, Burlington & Quincy R.R. at Kansas City, Mo., has been contemplated, and some study of the situation has been made by the railway company, but we are informed officially that there is no prospect of any work being done in the near future, especially in view of the present financial situation. The general plan is said to be to construct a new double-track bridge a short distance upstream from the present single-track bridge. This present bridge is quite strong enough for the modern equipment, but the main purpose of a new structure would be to increase the train capacity by means of a double track. The old bridge, known as the Hannibal Bridge, was built in 1869, but its superstructure was rebuilt in 1891. It has six fixed truss spans and a swing span.

More Rapid Reinforced-Concrete Construction—In our issue of Nov. 12, 1914, p. 966, we noted a large concrete warehouse in Brooklyn on which very rapid work was done. We now have to report similar fast construction on the new building now nearing completion for the Stanley Works at New Britain, Conn. This building, which is being put up by the Aberthaw Construction Co., of Boston, measures 63x203 ft., seven stories and basement. Ground was broken during the first week of August, the foundations poured on Aug. 28 to Sept. 11, the first-floor slab on Sept. 14 to 16, the second-floor slab Sept. 17 to 19, the third-floor slab on Sept. 24 to 28, the fourth-floor slab on Oct. 1 to 5, the fifth-floor slab on Oct. 8 to 12, the sixth-floor slab on Oct. 15 to 21, the seventh-floor slab on Oct. 24 to 28. Roof centering was erected Oct. 29, and the last section poured Nov. 5.

The Flood Prevention Committee of the Miami Valley, Ohio, has decided to complete plans for flood protection without waiting for the final court decision on the legal questions involved, and the following men have recently joined the staff of the Morgan Engineering Co., which is making these plans: J. H. Kimball, M. Am. Soc. C. E., formerly Acting Chief Engineer for the Commissioners of Sewerage of Louisville, Ky.; B. M. Jones, formerly with the Electric Bond & Share Co., New York City; Walter M. Smith, M. Am. Soc. C. E., formerly Designing Engineer, and H. S. R. McCurdy, M. Am. Soc. C. E., formerly Division Engineer of the Board of Water Supply of New York City; Alfred B. Mayhew, Assoc. M. Am. Soc. C. E., formerly Designing Engineer on Arrowrock Dam, Idaho, U. S. Reclamation Service; S. M. Woodward, M. Am. Soc. M. E., Professor of Hydraulics, Iowa State University. Final hearing before the Supreme Court of Ohio on the constitutionality of the Ohio Conservancy Act will be held Nov. 12.

An 8-ft. Waterway in Illinois, connecting the Chicago drainage canal with the Illinois River, has been proposed as a substitute for the former projects for waterways having depths of 14 and 20 ft. to the Mississippi River. A report on this new project has been made to Governor Dunne by a board of engineers composed as follows: Lyman E. Cooley, consulting engineer for the Sanitary District of Chicago; E. J. Kelley, assistant chief engineer of the District; Walter A. Shaw, of the Illinois Public Utilities Commission, and L. K. Sherman, of the Illinois Rivers and Lakes Commission. The route would be from the end of the drainage canal at Joliet to La Salle, Ill., a distance of 65 miles. Of this, 45 miles would be improvement of the Illinois River, the remainder being mainly sections of the old Illinois & Michigan canal. There would be five sets of levels, and two new dams in the river. The cost is estimated at about $3,000,000, and would be paid by the state without waiting for assistance from the U. S. Government.

The Specifying of a Patented Pavement by the city of Rochester, N. Y., has been upheld by the New York Supreme Court in a decision handed down, Oct. 28, and the city is at liberty to proceed with the paving of Culver Road with "bitulithic" pavement. Three taxpayers sought to restrain the city and the contractor who had been awarded the contract on the ground that the common council had no power to pass an ordinance for a pavement of the kind indicated by the taxpayers in their petition, because this was a patented process, and so a barrier to competitive bidding. The plaintiffs were interested parties, having submitted a bid not in accord with the specifications for "bitulithic" pavements. The justice held that since the owners of the "bitulithic" process were willing to release the actual construction work to any person who succeeded in getting the contract, that the principle of competitive bidding was not destroyed, but was distinctly preserved, as shown by the fact that a number of bids were submitted in good faith.

A 2,500,000-gal. Steel Water Tank, 100 ft. in diameter and 44 ft. 3 in. high, is being built by the Massachusetts Metropolitan Water Board, on Belleview Hill, in West Roxbury, to serve as a reservoir for the Southern Extra High Service. The concrete foundation has been completed by John E. Palmer, Boston, Mass., and the work of erecting the steel is being done by Walsh's Holyoke Steam Boiler Works, Holyoke, Mass. The bottom of the tank, which rests directly on the concrete foundation, is of ⅝-in. plates, while the side plates vary from ⅞-in. at the bottom to ⅜-in. at the top, there being seven courses. The horizontal lap joints are double riveted and the vertical butt joints have plates on both sides with special rivet arrangements. The lowest course of side plates is connected to the bottom by means of 6x3½x⅝-in. Ls and the top of the tank is stiffened by 3x⅜-in. Zs. The steel for the plates conforms to the Standard Specifications of the American Society for Testing Materials for flange steel, except that the tensile strength is required to be between 57,000 and 62,000 lb. per sq.in. The butt joints are planed so as to be in perfect contact throughout and all calking edges are beveled. Rivet holes in all plates thicker than ⅝ in. are either drilled from the solid or punched ⅞ in. smaller and reamed.

PERSONALS

Mr. Ralph H. Wilson has been appointed Advertising Manager of the Walter A. Zelnicker Supply Co., St. Louis, Mo.

Mr. W. L. Schneider has been appointed Inspector of Transportation of the Delaware & Hudson Co., with offices at Albany, N. Y.

Mr. S. E. Hutton, M. Am. Inst. E. E., Consulting Engineer, of Moscow, Idaho, has been appointed Engineer of the Public Utilities Commission of Idaho.

Mr. Olin H. Landreth, Professor of engineering at Union College, Schnectady, N. Y., has been elected a district delegate to the State Constitutional Convention.

Mr. M. F. Clements, M. Am. Soc. C. E., of Ridgefield, Wash., has been appointed Engineer in charge of track elevation of the Northern Pacific Ry. at Spokane, Wash.

Mr. H. N. Underhill, formerly with the Underpinning & Foundation Co., New York City, is now associated with the MacArthur Concrete Pile & Foundation Co., 11 Pine St., New York City.

Mr. H. M. Sperry, M. Am. Soc. C. E., for many years Sales Engineer of the General Railway Signal Co., Rochester, N. Y., has been appointed Manager of the department of publicity and education recently organized by his company.

Mr. R. J. Potts, former Professor of highway engineering at the Agricultural and Mechanical College of Texas, and recently with the Potts-Moore Gravel Co., Waco, Tex., has been appointed Engineer of the proposed country drainage district, including part of the City of Waco.

Mr. Elmer Ambrose Sperry, M. Am. Inst. E. E., of New York City, has been awarded the John Scott Legacy Medal and Premium by the City of Philadelphia, acting on the recommendation of the Franklin Institute. Mr. Sperry is made this award in recognition of his gyro compass.

Mr. M. Liebel, Jr., President of the Liebel-Binney Construction Co., General Contractors, Erie, Penn., has been elected a member of Congress from the 25th Pensylvania district. Mr. Liebel is also President of the Vulcan Rubber Co. and is identified with many manufacturing interests in Erie.

Mr. A. C. Bradley, recently Road Master of the Chicago, Rock Island & Pacific Ry. at Iowa City, Iowa, has been appointed Division Engineer of the Oklahoma division, with headquarters at El Reno, Okla., succeeding Mr. Garrett Davis, who has been transferred to the valuation work of the railway.

President R. C. Sturgis, of the American Institute of Architects, has appointed the following members of a committee to act in an advisory capacity to the Lincoln Highway Association: Messrs. Elmer C. Jensen, of Chicago, Ill.; Wilbur T. Mills, of Columbus, Ohio, and Benjamin Hubbell, of Cleveland, Ohio.

Mr. E. N. Brown, for many years President of the National Rys. of Mexico, has resigned. He has been connected with the construction and operation of the Mexican Rys. since 1887, when he was Engineer in charge of construction of the railway from Saltillo to San Luis Potosi. Later he was made Division Superintendent of this division.

Mr. Garrett B. James, of the engineering staff of the Underwriters Laboratories, Chicago, Ill., has been appointed Consulting Engineer of the U. S. Bureau of Mines, to carry on an investigation of the subject of oil fires. Mr. James has been granted a three months' leave of absence by the Laboratories and is now in the Texas oil fields.

Messrs. C. S. Rindsfoos, recently Secretary-Treasurer of the Foundation Co., New York City, and N. C. Fallor, recently Manager of the machinery department of the Canadian Fairbanks-Morse Co., Montreal, Que., announce that they have formed the United States Purchasing Corporation, with offices in the Woolworth Building, New York City.

Mr. Lynn E. Perry, Jun. Am. Soc. C. E., has been admitted to the firm of Oldfield & Brady, Cairo, Ill. The firm will be known under its present name. Mr. Perry was formerly with the staff of the New York City Board of Water Supply and the Philadelphia Bureau of Surveys. He will take charge of sewer and drainage projects soon to be begun by the firm.

Governor Haines, of Maine, has appointed three lawyers, Messrs. Benjamin F. Cleaves, of Biddeford; William B. Skelton, of Lewiston, and Samuel W. Gould, of Skowhegan, members of the State Public Utilities Commission, created by the new law which went into effect Oct. 30. The salary of the chairman is $5000 per annum, and of the other two members, $4000 per annum.

Mr. John M. Rapelje, recently Assistant General Manager of the Northern Pacific Ry. at St. Paul, Minn., has been promoted to be General Manager of the lines east of Paradise, Mont., succeeding the late E. A. Goodell. Mr. Rapelje was born in Canada in 1857 and began his railway experience as a brakeman on the Grand Trunk Ry. In 1898 he was a conductor with the Northern Pacific.

Mr. H. S. Van Scoyoc, Assoc. M. Am. Soc. C. E., recently Inspecting Engineer of the Canada Cement Co., Ltd., Montreal, Que., has been appointed Chief Engineer of the Toronto-Hamilton Highway Commission, which is to build a new highway between Toronto and Hamilton, Ont. Mr. Van Scoyoc was born in Philadelphia, Penn., and is a graduate of the University of Pennsylvania.

Mr. J. Vipond Davies, M. Am. Soc. C. E., Vice-President of Jacobs & Davies, Inc., Consulting Engineers, 30 Church St., New York City, has been awarded the Telford Gold Medal of the Institution of Civil Engineers, London, England, for his paper on the "Extensions of the Hudson River Tunnels of the Hudson & Manhattan R.R." This is the most coveted honor conferred by the Institution of Civil Engineers for the literary and professional accomplishments of its members.

Mr. F. C. Magruder, Assoc. M. Am. Soc. C. E., who for the past 11 years has been with the United States Reclamation Service, having been in charge of the Belle Fourche Project in South Dakota for the past four years, and Stephen C. Berry, also formerly with the U. S. Reclamation Service, have formed a partnership to engage in the general practice of engineering at Belle Fourche, South Dakota. Special attention will be given irrigation systems, drainage systems and municipal water-works.

Mr. Walter T. Spencer, Assoc. M. Am. Soc. C. E., former Division Engineer of the New York, New Haven & Hartford R.R. at Waterbury, Conn., and Providence, R. I., has been promoted to be Division Superintendent of the Old Colony division, with headquarters at Taunton, Mass., succeeding Mr. H. C. Oviatt, promoted. Mr. Spencer was born in 1869 and graduated from Sheffield Scientific School, Yale University, in 1890. He was Division Engineer from 1893 until September, 1914, when he changed to the operating department as Trainmaster at Providence, R. I.

Dr. J. A. L. Waddell and Mr. John Lyle Harrington, M.'s Am. Soc. C. E., announce the dissolution of the firm of Waddell & Harrington. The firm's business will be conducted as usual until the conclusion of its affairs in July, 1915, except that it is accepting no new commissions. Dr. Waddell will give his attention to special engineering and financial matters and to important advisory work. Mr. Harrington will be joined by the firm's Associate Engineers, Messrs. E. E. Howard, M. Am. Soc. C. E., and Louis R. Ash, M. Am. Soc. C. E., in the establishment of the firm of Harrington, Howard & Ash, Consulting Engineers. Mr. Howard has been associated with Dr. Waddell for 14 years; for many years he was Principal Assistant Engineer and later Associate Engineer of the firm of Waddell & Harrington. Mr. Ash was formerly City Engineer of Kansas City, Mo., which office he resigned to become Associate Engineer and Office Manager of Waddell & Harrington. The new firm of Harrington, Howard & Ash is already engaged in a general consulting practice, including the design and construction of movable bridges. The principal office of the new firm is 1012 Baltimore Ave., Kansas City, Mo.

OBITUARY

Charles J. Bandmann, a mining engineer, of San Francisco, Calif., died Nov. 1.

William H. Olenburg, Treasurer and Superintendent of the Ohio Machine & Boiler Co., Cleveland, Ohio, died Oct. 9.

John Kilgour, former President of the Cincinnati Street Ry. Co., died Oct. 30, at his home in Cincinnati, Ohio, from pneumonia. He was 80 years old.

Charles O. Kruger, President of the Philadelphia Rapid Transit Co., died Nov. 4, in the rooms of the Racquet Club. He was born in Philadelphia in 1864.

Charles M. Gould, Vice-President and Treasurer of the Gould Coupler Co. and the Gould Storage Battery Co., New York City, died Oct. 20, at his home in Bayside, Long Island. He was born in Buffalo, N. Y., in 1873. He was the son of Charles A. Gould, founder of the company.

Emil Kuichling, M. Am. Soc. C. E., one of the best known American hydraulic engineers, died on Nov. 9, at his home in New York City. Mr. Kuichling was born at Kehl, Germany, Jan. 20, 1848. In his early youth he came to the United States and was graduated from the University of Rochester as a civil engineer in 1869; he later studied at Carlsruhe, Germany. His early engineering work was in connection with the New York State canals, of which he was chief engineer from 1890 to 1900; since that time he has been in consulting practice in New York City. A more extended biography of Mr. Kuichling will appear in our next week's issue.

F. Augustus Heinze, M. Am. Inst. M. E., owner of large copper interests in the West, died Nov. 4, at his home in Saratoga, N. Y. He was born in Brooklyn in 1869 and was educated at the Brooklyn Polytechnic Institute and the Columbia University College of Mines, where he graduated in 1889. After studying some time in Germany, he went to Montana, where he became, when not more than 30 years old, a prominent figure in the copper-mining industry. Of late years he gained considerable notoriety because of his connection with several banking institutions, and he was indicted by a federal grand jury for mismanagement of the Mercantile National Bank, New York City.

Henry Gannett, Geographer of the U. S. Geological Survey, President and one of the founders of the National Geographic Society, died at his home in Washington, D. C., Nov. 5. He was the father of Farley Gannett, Assoc. M. Am. Soc. C. E., Engineer of the Pennsylvania Water Supply Commission. Henry Gannett was born in Bath, Maine, in 1846. He graduated from Lawrence Scientific School, Harvard University, in 1869. He served as a topographer on the Hayden survey of the territories, before the formation of the U. S. Geological Survey. He was made Chief Geographer of the Geological Survey in 1882. He was Assistant Director of the Philippine census and of the Cuban census in 1907. He was the author of many scientific publications and a member of many scientific and learned societies.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ROAD CONGRESS.
Nov. 9-14. Atlanta, Ga. Permanent headquarters, American Highway Association, Colorado Building, Washington, D. C.

INDUSTRIAL WELFARE AND EFFICIENCY CONFERENCE
Nov. 16-20. Conference at Harrisburg, Penn. Secy., R. M. Pennock, Harrisburg, Penn.

NATIONAL MUNICIPAL LEAGUE.
Nov. 17-21. Annual meeting at Baltimore, Md. Secy., Clinton Rogers Woodruff, North American Building, Philadelphia, Penn.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
Nov. 19-20. Annual meeting at Columbus, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Nov. 30-Dec. 1. Annual meeting at New York. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Nov. 30-Dec. 5. Annual meeting at Jacksonville, Fla. Secy., Prof. Selskar M. Gunn, Massachusetts Institute of Technology, Boston, Mass.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 1-4. Annual meeting at New York City. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 2-4. Convention at Washington, D. C. Secy., D. Knickbacker Boyd, The Octagon, Washington, D. C.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 7-10. Annual meeting in New York City. Secy., Percy H. Wilson, Bellevue Court Bldg., Philadelphia, Penn.

AMERICAN MINING CONGRESS.
Dec. 7-11. Annual meeting at Phœnix, Ariz. Secy., J. F. Calibreath, Denver, Colo.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 9-12. Convention at Richmond, Va. Secy., C. A Prosser, 140 W. 42d St., New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 10-11. Annual meeting at New York City. Secy., D H. Cox, 29 W. 39th St., New York City.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 14-18. Convention at Chicago, Ill. Secy., E. L. Powers, 150 Nassau St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 28-30. Annual meeting at Madison, Wis. Secy., F. M. White, Madison, Wis.

Society for the Promotion of Engineering Education—The annual meeting will be held at the Iowa State College, Ames, June 22-25. The Secretary is H. H. Norris, 29 W. 39th St., New York City.

American Institute of Consulting Engineers—The following questions will be considered, at a meeting of the Institute to be held at 8 p.m., Nov. 12, at the City Club, New York City: "A Memorial to Alfred Noble"; "Legislation for the Registration of Engineers"; "The Coming Constitutional Convention in New York State."

Pan-American Scientific Congress—The United States, through the Department of State, has invited all the governments of this hemisphere to a Pan-American Scientific Congress, to be held in Washington, D. C., in October, 1915. The first congress of this kind was held in Santiago, Chile, Dec. 5, 1908. The business enacted will be of a general scientific nature, including a department of engineering. The five national engineering societies of the United States, Civil, Mining, Electrical, Naval Architects, and Mechanical Engineers, have been invited to assist in the preparation of the program on engineering. It is believed that this assistance should include suggestion of authors of papers, suggestion of names of the biggest men in the engineering field in the different countries, and urge their appointment as delegates to the congress, and to see that adequate reception for them is provided by the industrial concerns of the United States.

American Road Congress—The fourth of these congresses opened on Monday, Nov. 9, with a registration of 1730. The first session was addressed by Governor Slaton and Senator Hoke Smith, of Georgia, and by Mayor Woodward, of Atlanta. At the same session Logan Page, Director, Office of Public Roads, Washington, D. C., said:

Government statistics show that a hard surface was laid on 18,000 miles of additional road in the United States in 1914. This equals three-fourths of the road mileage of France. The road expenditures of the United States in 1914 amounted to $225,000,000.

Federal-aid legislation was the subject of the Monday afternoon session, which was addressed by Congressman W. P. Borland, of Missouri.

A reception to the delegates was held by Governor Slaton on Monday evening.

There is a large display of road machinery. The convention will extend through the whole week.

American Concrete Institute—The 11th annual convention will be held at the Auditorium Hotel, Chicago, Ill., Feb. 9-12, 1915. The preliminary summary of the program is as follows:

Tuesday, Feb. 9, Concrete Roads, Sidewalks and Bridges—Important papers and discussions relating to the status of concrete-road construction in the United States will be presented, and special attention given to costs, repairs and maintenance.

Wednesday, Feb. 10, Concrete and Reinforced Concrete Tests and Design—Discussion of the very important column tests made by the Institute at Pittsburgh, tests of buildings, and other matters of current special interest.

Thursday, Feb. 11, Concrete in Art and Architecture—Discussion of architectural design in concrete, dimension and art concrete stone, treatment of surfaces, etc.

Friday, Feb. 12, Plant Management and Costs—This day will be devoted to concreting plants, covering plant management and costs, the design and cost of wood and metal forms, and the methods of placing, proportioning and selection of concrete materials.